A

TREATISE

ON THE

STRUCTURE, ECONOMY, AND DISEASES

OF

THE EAR;

BEING

THE ESSAY

FOR WHICH THE FOTHERGILLIAN GOLD MEDAL WAS AWARDED BY THE MEDICAL SOCIETY OF LONDON.

BY GEORGE PILCHER,

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PREFACE.

THE following Treatise owes its appearance in print to the circumstance of several friends, who perused it after the adjudication of the Fothergillian Medal; expressing a wish that it should be given to the public, as calculated to supply a desideratum in medical literature. Whether that opinion was influenced by partiality, or whether the Essay be of value sufficient to justify its publication, will be decided by a liberal Profession.

The account of the Anatomy and Physiology of the Ear precedes that of its morbid state, in accordance with the conditions imposed by the Council of the Medical Society; the different parts, however, are distinct, therefore the Members of our Profession, being acquainted with the healthy organ, may refer at once to the history of its diseases without inconvenience.

My thanks are due, and are with much gratification given, to Mr. Swinburne, Mr. Hemming, and Mr. Appleton, to whose pencils I am obliged for the elucidations; to Mr. Amyot, Mr. Bryant, Mr. Callaway, Mr. Liston, Mr. Masterman, Mr. Maurice, Mr. Moore, Mr. Rendle, Mr. Sanders, who have furnished me with the reports of several interesting cases which have occurred in their practice, and which appear in this Essay; and particularly to my colleagues, Mr. Grainger and Mr.

Barron, for the assistance they have rendered me in arranging the sheets for the press, and in their subsequent revision.

GEORGE PILCHER.

September, 1838.

A Second Edition having been called for earlier than was expected, the Author has been obliged to limit the alterations to a few verbal corrections. He has, however, taken this first opportunity of appending a concluding Summary, and having the whole of the plates re-drawn, which he trusts will render the work more deserving the approbation already bestowed upon it.

7, *Great George Street, Westminster*,
January, 1842.

[The *Notes* to the American edition, in illustration and extension of the views of the Author, are designated by the letter (*a*).]

January, 1843.

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INTRODUCTION.

It might have been reasonably anticipated that the immense improvements which have been introduced into Ophthalmic Surgery by the labours of some of the most distinguished members of our profession, would have induced the educated practitioner to investigate those numerous diseases to which the Ear is obnoxious. Such, unhappily for the welfare of mankind, has not been the result; and thus it happens that even at the present time, in this country at least, Aural Surgery is either almost entirely neglected, or for the most part is left in the hands of the ignorant empiric. In consequence, therefore, of what must be considered a dereliction of duty on the part of English surgeons, the unfortunate sufferers from these distressing maladies are, in many instances, abandoned to their fate, or compelled to seek relief from the employment of nostrums which it would be but too charitable to regard as being merely harmless in their operation.

It is not too much to affirm, that until the morbid affections of the ear be treated according to the general principles of pathology, and more especially until the study of these affections be regarded as constituting a necessary and essential part of medical education, it would be in vain to hope for any considerable extension of the very limited knowledge which is at present possessed on this interesting class of diseases. The Council of the Medical Society of London, in selecting as the subject-matter of the Essay to which the Fothergillian Medal for the present year was to be adjudged, "The Structure, Economy, and Diseases of the Ear," were doubtless influenced in their

choice by considerations of this nature; and whatever may be the merits of the various treatises written with the hope of obtaining the honourable preference of the Society, it is evident that the Council, by thus pointedly calling the attention of the profession to this question, have conferred an obligation of no ordinary amount on the community, and have thus judiciously fulfilled the benevolent intention of the enlightened and liberal physician who committed this important trust to their charge.

The subject proposed is very extensive, and will certainly require some powers of condensation to treat it fully within the space usually allotted to an Essay. I shall, however, prefer risking the charge of being prolix or tedious, to omitting what may appear to me as essential in the history normal and abnormal of the Ear. I cannot hesitate to understand, that reference is made by the proposers of the subject exclusively to the human Ear; and yet the term "Economy" would justify the supposition that the Essayist might be expected to travel a short distance into the wide and fertile field of comparative anatomy, to collect facts tending to elucidate the physiology of the human organ.

I purpose, therefore, in treating this subject, after making some general observations upon the sense, to take a slight sketch of the development of the organ in the animal gradation; and to dwell particularly upon the anatomy of the human Ear. The physiology will properly follow the anatomy; and in discussing this part of the subject, I intend to premise the application of sound to the Ear, by some general allusions to Acoustics. The history of the abnormal condition of the organ, including some observations upon its malformations and injuries, will constitute the concluding and most important part of the Essay.

PART I.

GENERAL OBSERVATIONS.

CHAPTER I. — Section I.

Hearing is an animal sense, the effect of undulations of airs or fluids, or of vibrations of solids upon a special nerve, produced through the medium of an apparatus, more or less complicated, and by which important perceptions of the external world are acquired.

So important is sound in conveying information to the sensorium, that some physiologists have ranked the Ear higher in utility than the Eye; but apparently upon insufficient grounds; for, as this organ is not so generally found in the animal series, it would rather seem that Hearing is of secondary importance to Vision in procuring food, and in avoiding danger. Thus, for example, many of the mollusca and articulata possess a demonstrable organ of the latter sense, whereas in but few, as will presently be apparent, can any indication of the former be detected. In the higher classes of animals, in which both organs are perfected, the ratio of comparative utility certainly differs in different species; for while the animal of prey seeks his food rather through the assistance of his sight and smell than of his hearing, the timid victim has its Ear ever upon the alert to catch the slightest sound of its approaching enemy, yet in all instances the palm of utility must be yielded to sight, by the operations of which the creature becomes acquainted with objects not

only at a greater distance, but also far more speedily, and far more accurately.

Although the more extensive existence of vision in the animal creation as compared with audition has been adduced in proof of its greater utility, yet it is not to be received as a general conclusion that the greater the importance of a function, the more universal will be its organ, for the reverse is particularly the fact in those of animal life. Thus is it found that first, feeling, and secondly, smelling, are more generally present in the animal series; perhaps, indeed, it might be assumed, that all undoubted animals possess the former of these faculties, and many zoophytes, very low in the scale, are directed to their food through the medium of their sense of smell. The general arrangement appears to be that the lowest animal possesses only the lowest faculties of sense, — and that as the higher of these powers are developed, the lower are comparatively, though certainly not absolutely, diminished in importance. The exception to this generality is in the two highest, where we find that sight, the highest animal sense, is met with more early and more generally than an unequivocal sense of hearing.

When, however, we at last turn our attention to man, then do we find the importance of hearing most remarkably augmented, from its intimate connection with speech. The human being who has been blind from infancy, would doubtless shrink from the idea of exchanging his acute hearing for perfect sight; yet are there few enjoying the benefit of both senses, who do not feel that a greater amount of happiness is the product of vision than of audition; and with a full consciousness of the all-delightful and rapid, — and delightful because rapid — interchange of thought, by the means of conversation, of the all-pleasing, all-exhilarating, all-soothing influences of musical concord, still must we feel that the deaf man has to be thankful that it is not his sight of which he is deprived.

But when we recollect the melancholy state of insulation of the deaf and dumb, and remember that deafness from birth inflicts upon the individual deprivation of the splendid faculty of speech, — and when we recall to our minds many blind from their birth who are proficients in

music; who have acquired vast information; who have made considerable progress in the mechanical arts; even sometimes in the more difficult sciences, as exampled in a celebrated professor of mathematics, and who thus perform their parts of usefulness in the great machinery of society, we are undecided whether to be deprived of sight, or of the conjoined faculties of hearing and speech, be the greater evil.

It has been stated in the definition that hearing is an impression made upon the auditory nerve, and of this fact no doubt exists in the normal condition: yet, it does appear that an influence may be communicated to the sensorium by vibrating bodies, without the intervention of the acoustic apparatus, so similar to hearing, if it be not hearing itself, that there would seem to be reason for imagining that the mind, ever watchful to perceive the properties of surrounding bodies, will receive those perceptions through the medium of some other sense, when that, whose peculiar office it is to convey these especial impressions, is deficient normally or abnormally. Thus by many comparative physiologists it is believed that most insects not furnished with an Ear, hear by their tentacula, which is supposed to be evidenced by their avoidance of loud sounds, &c.; and the writer has known a musical amateur, though perfectly deaf, enjoy in a high degree the sensations produced by a good performance upon a church organ. These impressions may rather be attributed to an augmentation in the sense of *feeling;* for undulations of the air, so minute as to produce only sound to higher beings, may be as readily *felt* by the more sensitive organs of the insect, as a rude blast may be by the surface of our bodies; and the varied vibrations of the building, or even of the solid earth, may be distinctly *felt* and appreciated, through the medium of the entire frame, but particularly the skeleton, so as to produce a harmonious impression, whereas under ordinary circumstances an indistinct vibratory motion only would be perceived. But it may be said, that in these instances the auditory nerve is the agent through which the brain is influenced, as the nerves distributed to the tentacula may correspond partly to the acoustic; and in the latter case, though the

organ of hearing be itself disorganized, yet the portion of its nerve connected with the brain still enjoying its function, may receive the impressions above noticed, and convey them to the sensorium. Thus it becomes possible that every animal, however low in the scale of creation, may possess a sense of feeling excited by vibrations of the fluid or air in which it lives, analogous to true audition.

De Blainville describes Hearing as necessarily connected with voice and speech, and, therefore, as partaking more of the *animal* character than the other senses, — a theory which is doubtless correct when applied to the higher classes; but, as the Ear is found in some articulata, and in all fishes, which, wanting lungs, cannot be supposed to possess voice, it is certain that this sense must exist for other purposes than mental communication; as, for example, to warn the individual of the approach of danger, or of its prey, and in an especial manner, probably, to facilitate the approximation of the sexes, a surmise, which is corroborated by the fact, that Hearing is absent in those species in which the sexual organs are united in the same individual.

Section II.

De Blainville, who has probably given to the scientific world the most accurate and simple history of the comparative anatomy of the Ear, has made four divisions of this apparatus.

1st. *The essential or fundamental portion — the Vestibule;*

2d. *The part for perfecting Hearing; the semicircular Canals and the Cochlea;*

3d. *The portion occasioning unison and strength in sounds, the Tympanum;*

4th. *The accessory part for the reception of the sonorous rays, the External Ear.*

This division, being founded upon the comparative development in the animal series, is correct, and is moreover eminently useful in studying the economy of the

Ear. It is found, not only that one division is superadded to the rest, in accordance with the increased necessity of the sense; but that each division becomes also more complicated, till it reaches its perfection in the human Ear.

Section III.

1st. *The essential or fundamental part of the Ear* is the *Vestibule*, so named from its position, in the fully devoloped organ between the second and the third divisions. It is a membranous sac, varying in size and figure, most frequently oval, and comparatively larger, when it exists as the entire Ear, than where it only constitutes part of a more complicated apparatus. It is contained in a corresponding fibrous, cartilaginous or bony cavity, which has an internal orifice for the admission of vessels and nerves; and one external for connexion with the vibrating fluid around, usually denominated the fenestra ovalis; which last is closed by the sac of the vestibule, somewhat perhaps there thickened, so as to constitute the membrana fenestræ ovalis. The vestibular sac is vascular, and more or less intimately attached to the parietes by the periosteum, perichondrium or cellular membrane. Within it is another, or third layer, supporting the filaments of the acoustic nerve in a very delicate cellular tissue. The nervous layer does not line exactly the vascular, excepting in the simplest varieties: it sometimes, for instance, forms a transverse septum, sometimes folds floating in the fluid of the vestibule. Between the vascular and nervous membranes is contained a humour, almost entirely composed of water, but probably containing a minute quantity of albumen, and of saline matter, chiefly soda; it is supposed to be enveloped in a proper transparent membrane, as it preserves a determined figure, and appears to be smaller than the containing cavity when opened; it is partially suspended by filaments of nerves. In this fluid, or upon its surface, is contained a cretaceous or osseous body, which also in some cases appears to be attached to nervous fibrils. Another fluid is found in the vestibule of the more perfect Ears, between the fibrous

or periosteal and vascular membranes; it is that described by Cotunnus, and named after him; it certainly contains a trace of albumen and of soda. In consequence of the great delicacy of the membranes, and in most instances of the minuteness of the whole cavity, these two fluids have been confounded together; and some anatomists still doubt their separate existence.

This description may be generally applied to the vestibule, but important exceptions are met with both in the most simple and in the more complicated Ear.

The very simplest organ is formed of a vestibule alone, and even this is not clearly demonstrated, lower than the crustacea, for if the inferior classes of the order articulata, possess an Ear, it has not as yet been discovered. Entomologists, it is true, have attributed the faculty of hearing to the class insecta, and particularly the arachnoidea, give evidences of this sense, which is now generally supposed to reside in their antennæ, though, unfortunately for that opinion, spiders, which are supposed to hear the best, are not possessed of these peculiar organs.

Comparetti has not only described the Ear in insects, but has given many views of it; yet as other, later, and, as we should imagine, more careful investigators, have failed in discovering the organ, although directed to it by the account of his previous researches, we are therefore almost obliged to conclude, that Comparetti mistook some other structure for the Ear, —an error which might readily occur on account of the minuteness of the object, and especially by a mind fully expecting to meet what it was in search of. De Blainville's examinations have led him to discover in the grasshopper a very small orifice on each side the posterior part of the head, resembling a stigma leading to a little sac within; he asks if this be the Ear, or a communication with the trachea, and then suggests the possibility of its performing both offices by means of a peculiar nerve expanded upon its surface.

In a Treatise like the present, it can hardly be necessary to allude further to Comparetti's views, than to notice that he generally describes the Ear in insects, and in some of the cephalapods, as a simple vestibule, having the fenestra ovalis communicating with the surrounding

medium, whilst in one or two examples, he alludes also to pellucid canals communicating with this little sac.

The author cannot but again repeat his opinion that the assumed evidences of Hearing in the numerous tribes of insects, and the gasteropods, and, perhaps, in some of the still lower orders of mollusca, ought rather to be attributed to an exquisite sense of feeling, which faculty these animals are known to possess in an astonishing degree of perfection. Thus bees are collected into swarms by their own buzzings, and by the rattling of iron implements, but their ideas apparently are communicated through the medium of their delicate antennæ, crossed over each other in various manners, which thus become their organs of speech, as well as of hearing and feeling: it is probable that the former effects are the result of the sonorous vibrations acting upon their organs of touch.

The fundamental organ of Hearing is distinctly seen in the crustacea (Plate I., figs. 1 and 2): in which animals it consists of a simple sac, of a whitish colour, filled with fluid, and containing a small cretaceous body; this sac is pierced by the ultimate divisions of the acoustic nerve, some filaments of which appear to be attached to the rudimentary otolithe. The vestibule, becoming gradually smaller outwards and backwards, forms a fenestra ovalis, by perforating the shell at the lower surface of the first joint of the second pair of antennæ; the perforation is closed by a thickish white membrane, and protected by a little prominence of the shell. Dr. Roget describes a striated groove in the vestibule.

The cephalopods, as the cuttle-fish, nautilus, &c., being more especially aquatic, possess an Ear more nearly resembling that of fish; the organ having, as in those animals, an immediate communication with the surrounding fluid, and being placed at the inferior and posterior part of the head; besides the humour contained in the vestibule, there is now found a well-defined cretaceous body of a cruciform shape, adhering to the sac, and doubtless required for the purposes of vibration: the whole apparatus is contained in a cartilaginous cavity, partly occupied by cellular membrane. Projecting from

the surface of this cartilaginous cavity are four or five small tubercles of the same structure, in consequence of which, the membranous and cartilaginous surfaces being in contact only at those points, the vestibule must enjoy a degree of vibration corresponding to the aquatic habits of the animal. (Plate I., figs. 3 and 4.)

It is interesting here to notice that even this simple Ear is to be found only in connexion with a dense skeleton, the cuttle-fish having a rudimentary cranium : were it otherwise, it is to be presumed the vibrations would be insufficient to influence the nerve.

This fundamental part of the Ear constitutes the entire organ in the lamprey and the myxine, the lowest orders of fish ; the former does not appear to possess a cretaceous body, though one is found in the latter. They have in common with fishes in general no external auditory orifice.

PLATE I.

Fig. 1.— Internal view of the simple ear of the Lobster. a. Vestibule laid open. b. The acoustic nerve passing from the Brain to be expanded upon the Membrane of the Vestibule.

Fig. 2.— External view of the same. a. Opening of the Vestibule or Fenestra-Ovalis closed by its membrane, and defended by a rim of the shell — (as seen from beneath).

Fig. 3. — External view of the Vestibule of the Ear of the Cuttle-fish in its cartilaginous case, and supported by its ovoid cartilages, with blood-vessels ramifying upon it.

Fig. 4. — The same laid open, showing the acoustic nerve and cruciforme otolithe *in situ*.

Fig. 5. — Otolithe of the Dog-Fish
Fig. 6. . . Salmon
Fig. 7. . . Cod-Fish } of the natural size.
Fig. 8. . . Whiting
Fig. 9. . . Brill

Plate 1.

Fig. 1.

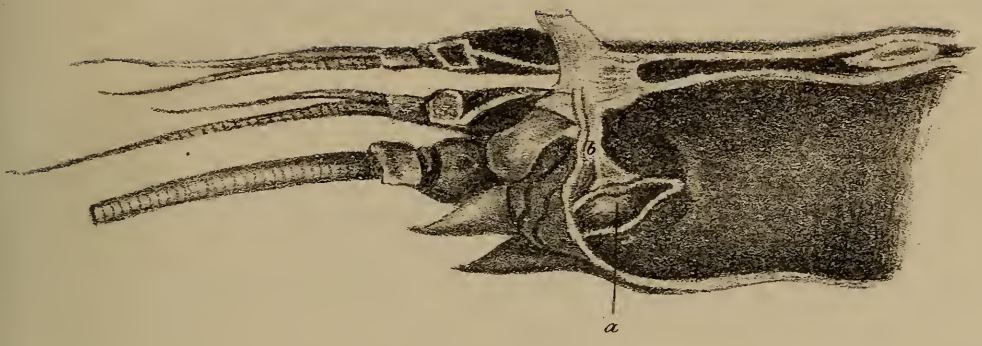


Fig. 2.

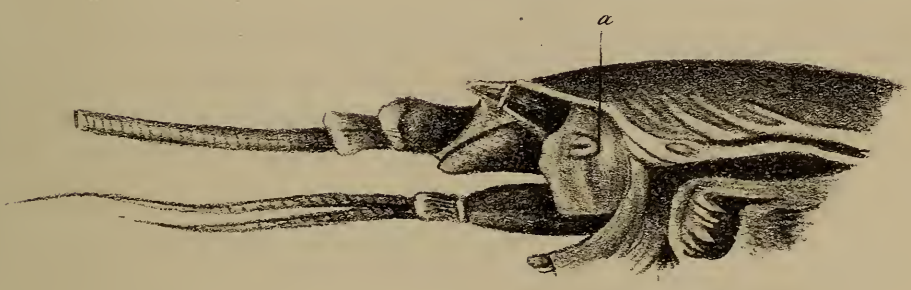
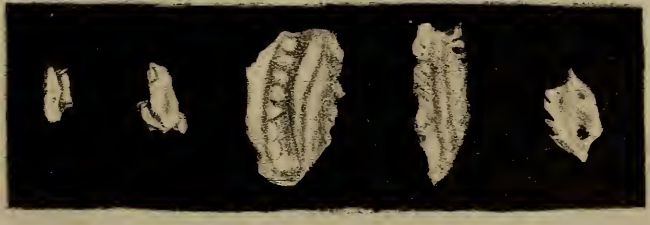


Fig. 3.

Fig. 4

Fig 5. 6. 7. 8. 9.



Section IV.

2d. *The second division, or parts for perfecting hearing. — The semicircular canals and the cochlea* constitute, with the vestibule, *the Labyrinth*, and by De Blainville are considered as diverticula or extensions of that essential part.

The Semicircular Canals, named from their shape, though they generally form three-fourths at least of a circle, are always three in number, and are placed at the upper and posterior part of the vestibule, in such a manner that two are vertical, one anterior and the other posterior, while the third is horizontal and external; they communicate by both extremities with the vestibule, sometimes by six openings, yet generally by five, in consequence of the two vertical uniting by the posterior crus of the superior and the superior crus of the posterior, to form a common canal; more rarely there are but four openings into the vestibule. These canals are cylindrical, except at that extremity of each, which may be termed the origin, where an enlargement exists, known under the name of the ampulla; this enlargement sometimes continues into the vestibular sac, but more frequently it first becomes again contracted. The Semicircular Canals consist, like the vestibule, of vascular sacs, lining fibrous, or cartilaginous, or bony passages; and contain within them other membranous tubes, corresponding in shape but much more contracted, and upon which the nervous filaments are largely expanded. These latter tubes are termed the *membranous semicircular canals.* The Aqua Labyrinthi occupies the space between the lining of the bony or cartilaginous canals and the membranous canals; these latter are also filled with a perfectly thin and transparent fluid, and in some cases, towards the ampullæ, chalky matter is likewise found.

The *Cochlea*, which is very frequently wanting, the canals being then the only part of the second division added to the vestibule, is thus named from its shape, which resembles the shell of the snail; it is situated

anterior and internal to the vestibule, and is a canal taking one, two, or three spiral turns: the cochlea is sometimes, as in the higher animals, divided into two passages, termed *scalæ*, by a spiral septum; under which circumstances, one of the divisions communicates with the vestibule, the other indirectly with the surrounding medium. In structure it corresponds to the rest of the labyrinth, in being a cartilaginous or bony canal lined by a vascular membrane, which contains the liquor cotunni, but it is not usual to find a second membranous tube within this fluid, the nerve being expanded upon the vascular lining.

The first distinctly recognised cochlea is met with in reptiles and in birds, whose ears very nearly correspond. In these creatures it is evidently a slightly curved elongation of the vestibule, and in the turtle, frog, &c., it is without any division; but in the crocodile, the highest of the reptile species, and in birds, a septum extends through it, producing a *scala vestibuli*, and a *scala tympani*. In the mammalia the cochlea becomes convoluted into a spiral canal, having a septum throughout, except at its apex, where a *canalis scalarum communis* is formed for the communication of the two scalæ, it thus corresponds to the general description given above.

Of the second Division, the Semicircular Canals much more generally exist in the animal series than the undoubted Cochlea; they are the first superadded elaboration to the simple vestibule, the fundamental part. Thus in fishes the organ consists of a vestibule and semicircular canals, having a few and not important peculiarities in different species, to which very brief allusion may be made. In the lower cartilaginous and osseous fishes, the whole Ear is contained in the cavity of the skull, on either side of, and projecting posteriorly to, the brain, immersed in the fluid which so nearly occupies the entire cavity of their crania, and which is supposed to be serum secreted by and occupying the distended cavity of the tunica arachnoidea. Under these circumstances the fluid of the skull, the chief intention of which appears to be to render the head lighter, and hence to regulate the specific gravity of the fish, must be the great medium through which the vibrations are communicated to the Ear.

Plate 2.

Fig. 1.

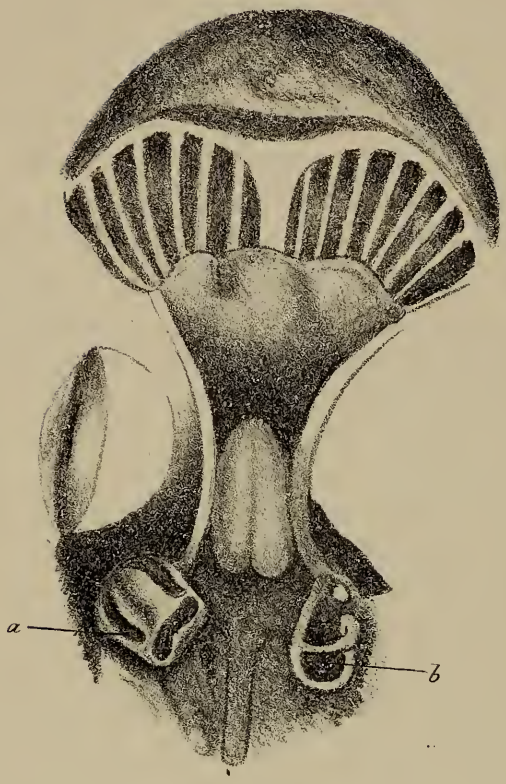
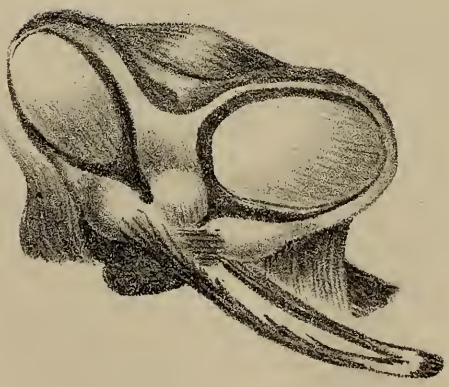


Fig. 2.



In the higher cartilaginous fishes, as the shark, the skate, esturgeon, dog-fish, &c., the inner wall of the vestibule alone projects into the cavity of the skull, and is in contact with the tunica arachnoides, whilst the other surfaces are surrounded by cartilage, which is now enlarged into a considerable prominence, to contain the semicircular canals. In the salmon and superior bony fishes, the semicircular canals are contained likewise in cartilage, the vestibule projecting into the cavity of the skull. The size and development of these structures is upon the whole relative to that of the fish, and they may be considered large in comparison with the same parts in mammalia. The vestibule, which is not divided by membranous partitions, is a little larger than the united mouths of the canals at their communication; it then somewhat suddenly expands into a *sacculus vestibuli*, in which is contained the otolithe, osseous or cretaceous, in character, and upon which are expanded many nervous filaments (Plate II., fig. 2). Weber has pointed out a communication between the air-bladder and the vestibule in the lower osseous fishes, by which means the former may possibly perform somewhat the part of an external Ear.

De Blainville and many other anatomists have considered this sacculus as the rudiment of the cochlea, and when it is considered that in the lower reptiles a pouch, more or less conical, proceeding from the vestibule, appears to be a further elaboration of this sacculus; that in the higher reptiles and in birds, this pouch is still further elongated and divided by a septum; and that thus a gradual transition to the convoluted cochlea of the mammalia is traced, it must be confessed that there is good reason to believe that the supposition is correct.

PLATE II.

Fig. 1. — The Semicircular Canals of a species of the Squalus.
a. The containing Cartilage partly removed.
b. Do. completely removed.

Fig. 2.— The ear of the Esturgeon, showing two of the Semicircular Canals (the horizontal being out of view) with the Ampullæ opening into the Vestibule, and the nerves expanded upon them.

The otolithe is bony, or rather shell-like, laminated, and hard, in the osseous and lower cartilaginous fish, as in the plaice, salmon, &c., of which sketches are annexed (Plate I., figs. 5, 6, 7, 8); in the higher cartilaginous species it is chalky, soft, or pulpy, effervescing in acid: in both it is a flattened oval, having a slight groove on its upper margin, by which it appears to be in contact with, and partially suspended by, the extremities of the nerves. In many of the osseous fishes there are two or three smaller bodies, suspended in the fluid, instead of one larger. Breschet, who first used the term of otolithes, has applied that of *otoconies* to the calcareous matter. These bodies vibrating in the fluid, and perhaps striking the sides of the vestibule, like the clapper of a bell, must very materially increase the influence of sound upon the auditory nerve.

The semicircular canals in fish are of great extent, with very minute cavities, rendering their walls thick, and thus guarding against too great a degree of oscillation; their ampullæ are large, generally contain otolithes, or rather otoconies, and receive the principal distribution of the nerve. The cartilaginous canals in the skate and other higher orders of fish, of which sketches are annexed (Plates II. and III.), are considerably larger than the contained membranous canals, the interspace being occupied by a fluid; this arrangement allows a vibration similar to that occurring within the cranium of the lower orders.

PLATE III.

Fig. 1. — *The Ear of the Thornback.* A. Cavity of the Cranium; B. Cerebral Lobes; C. Optic Lobes; D. Cerebellum; E. Medulla Oblongata. a. Fifth nerve; b. Acoustic nerve entering the Vestibule; c. Facial nerve; d. Vestibule; e. Semicircular canals exposed in the cartilage; f. Cartilage composing the walls of the cranium.

Fig. 2. — *The Ear of the Cod separated from its Cartilaginous canals.* — a. Sinus communis; b. Sacculus rotundus; c. posterior, d. anterior, and e. external semicircular Canals; f. Ampullæ of the canals; g. Utricule of the Sinus communis; h. Nervous trunk from which branches are given to the Sac, Utricule, and Ampullæ.

Plate 3

Fig. 1.

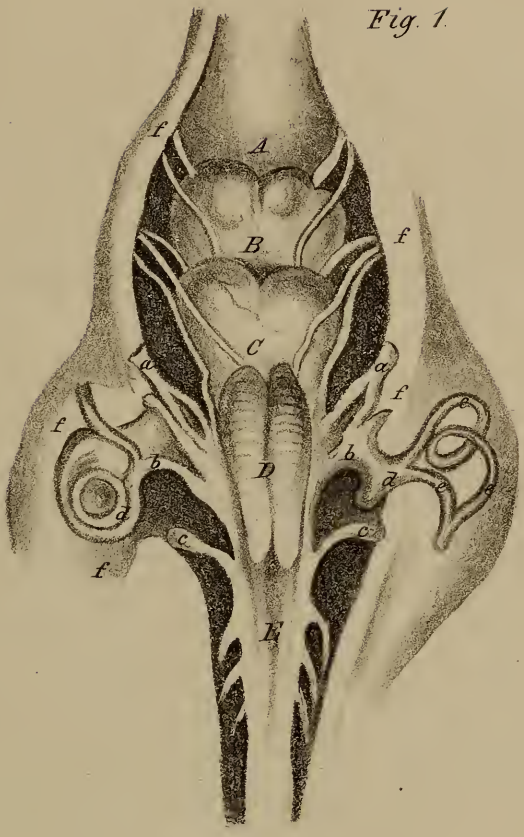
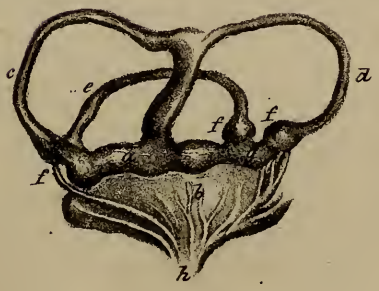


Fig. 2.



The skate, and others of the same class, have an interesting elongation from the upper and inner corner of the vestibule, which terminates in a fenestra ovalis, furnished with a membrane, and concealed by the skin between the eyes; hence the ears of these animals possess a communication with the surrounding medium, and are doubtless capable of producing more accurate perceptions. The description of the external ear of the skate by the first Monro appears to be incorrect, for he mistook the orifices of mucous follicles for external openings leading to the vestibule.

The semicircular canals of birds afford an interesting peculiarity in the union and decussation of the horizontal and posterior canals about their centre; the canals are large, the superior being especially prominent. (Plate IV.)

Having already alluded to the Cochlea, a few further observations will suffice to dismiss this part of our subject. As we examine the apparatus in the advancing series, we find probably a rudimentary cochlea in the sacculus vestibuli of fish; it is certainly found in reptiles, in which it is well defined, and in the crocodile and birds it is divided into two canals by a septum, more especially perhaps in the nocturnal birds, as the owl. In mammalia this appendage is always found, but not with an uniform development; in the whale it possesses but one turn and a half, being but rudimentary, whereas in the guinea-pig it has three turns and a half; in the greater number of mammalia it forms two and a half as in man, which may therefore be considered as the general type. In amphibia, reptiles, birds, and mammalia, all which possess the next division of the Ear, the tympanum, the labyrinth is encased in bone.

The *uses* of the second division of the Ear have been variously imagined; a doubt cannot exist that it increases the perfection of hearing, probably capacitating the animal to appreciate variations in sound, a supposition which is supported by the fact that perfect audition corresponds in general to the development of the labyrinth, though, as noticed above, the guinea-pig may be considered an exception, that animal having an extensive cochlea, without affording evidence of unusually acute hearing. It has

been asserted that the cochlea is the part of the organ appreciating minute and delicate sounds, in fact constituting, in higher animals, the musical Ear. It is not, however, so well developed in the singing birds as in mammalia, although most of the latter do not furnish proofs of such appreciation, and it is as well completed in the crow as in the nightingale; if it were merely to allow vibrations, a simple straight canal would probably answer the purpose better. The preceding details, afforded by comparative anatomy, evince that the semicircular canals are of more importance than the cochlea for simple hearing, whilst, for increased nicety of distinction, the latter is added; and the conclusion appears to be evident that the curiously convoluted and tortuous canals of the labyrinth, by extending the surface for the expansion of the nerve and the undulations of the fluid, conduce to the greater or less perfection of the impressions; and the perceptions of those impressions being entirely mental and independent of the external sense, man alone, with his fully developed brain, is capable of appreciating, in all their extent, impressions, which may be almost if not quite as perfectly formed upon the nerve in the labyrinth of the higher mammalia. This subject will be again alluded to in the section on physiology of hearing.

PLATE IV.

Fig. 1.—Dissection of the Turkey's ear, showing—a. The Meatus Externus; b. The Membrana Tympani; c. The Superior, d. the Posterior, and e. the External Semicircular Canals.

Fig. 2.—Another view, showing — a. The inner surface of the Membrane with the Columella passing to the Fenestra Ovalis; b. The Fenestra Rotunda, with a bristle passed through into the Cochlea; c. The posterior and external Canals crossing each other; d. The Superior Semicircular Canal.

Fig 3.—An internal view, the reverse of the above, showing — a. The inner surface of the Membrane; b. The Semicircular Canals; c. The Cochlea laid open with a bristle introduced through the Foramen Rotundum.

Plate 4.

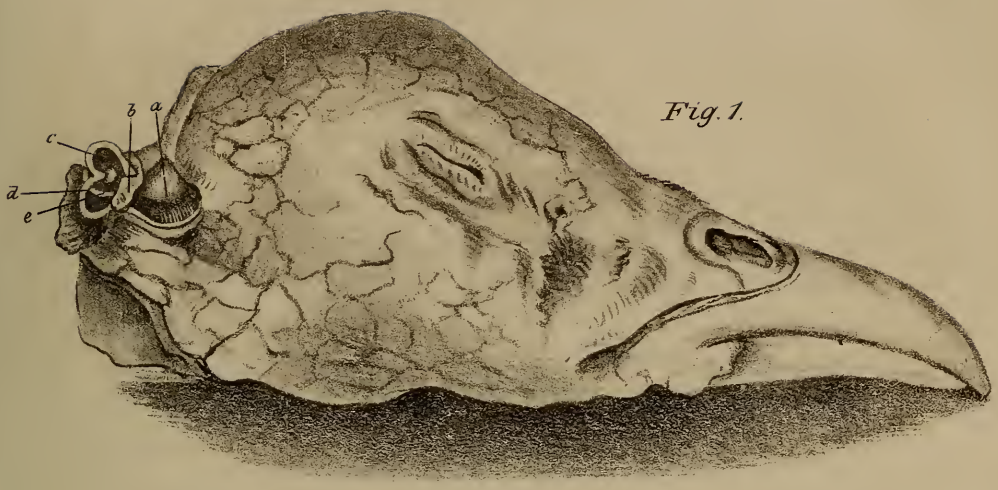


Fig. 1.

Fig. 2.

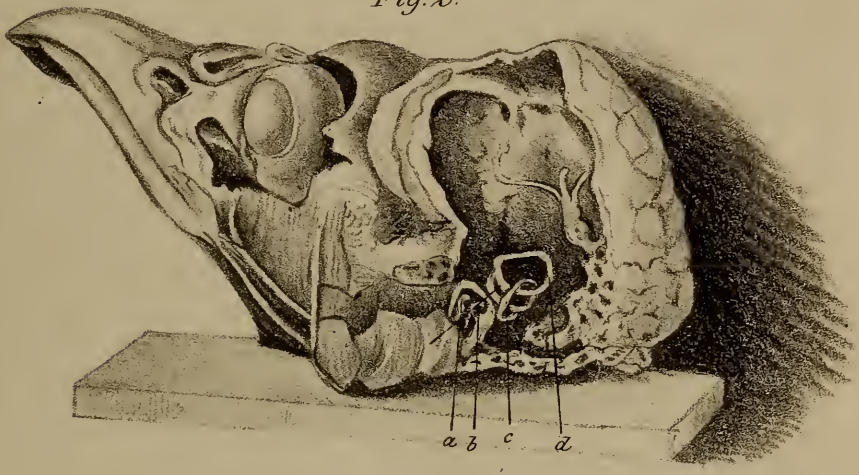


Fig. 3.

Section V.

The third Division of the Ear, — The Tympanum, which is so named from its partial resemblance in structure, and more intimate in function, to a drum, is of much less importance in the economy of hearing than the foregoing portions; being placed between the labyrinth and the surrounding medium, simply for the purpose of producing unison, and increasing strength in sounds. In animals which are possessed of an external Ear, properly so called, the tympanum constitutes the middle Ear. It is situated in the outer part of the petrous portion of the temporal bone in higher animals, and occupies the os quadratum or tympanic bone of birds. It may be correctly defined as a pouch of mucous membrane, placed in a cavity of the petrous bone, separated from the labyrinth by a septum, partly osseous, and partly membranous; the membranous portion occupying the *fenestra ovalis*, and another opening to be mentioned presently, termed the *fenestra rotunda:* it is divided from the surrounding medium by the *membrana tympani;* communicates with the respiratory and digestive canals, by a peculiar tube, the *Eustachian;* and by certain prolongations, extends into the cells of the cranium. The Tympanum is traversed by a single bone, the *columella*, or by a chain of three or four bones, the *ossicula auditus*, more or less horizontally extending from the inner surface of the membrana tympani to the outer surface of the membrana fenestræ ovalis. When a chain exists, the bones form angles with each other, more or less acute, and which may be varied by the action of certain muscles and elastic ligaments attached to the bones themselves. These ossicula convey the vibrations from the outer to the inner membrane, and having their angles, movements, and rotations varied and alternated, produce unison in, and thus influence the power of sounds.

We have seen that the external membrane of the lobster, and also of the skate, is to be considered as belonging to the fenestra ovalis, the slight elongation of the

vestibule which this membrane bounds, not being at all identical with a tympanum, though at first sight it may be so imagined; inasmuch as the membrana tympani of reptiles and amphibia, very closely resembles the membrana fenestræ ovalis of those lower beings. The tympanum is first found in the amphibia, and is further perfected in reptiles and birds, in which creatures it is very similar, with one or two unimportant exceptions, but is particularly neat and compact in the latter (Plates V. and VII.).

The membrana tympani, which in all these, as in the higher classes, is set in a groove in the petrous bone, is almost circular in the frog, tortoise, &c., the perpendicular diameter being slightly the longer: it is nearly a double plane; when otherwise, it is concave without and convex within. This membrane is formed by the mucous lining on its inner surface, and on its outer by the integument; but it is probable that it possesses a distinct intervening structure. Sir Everard Home described a muscular plane, radiating from the circumference to the centre, between the two reflected membranes, as being distinctly seen in the elephant and some other animals, and he suggests its existence throughout the whole series. In the amphibia the external covering of the membrane is very thick, and thus affords the protection required by aquatic existence, whilst in land reptiles and in birds it is much thinner, corresponding to their habits. The crocodile, living so frequently in air, is admirably furnished with an elongation of skin beyond the membrane, which, being valvular, forms a meatus externus when open, during the terrestrial sojourn of the creature, but becomes closed upon the membrane, when it plunges into the water, thus the organ is better adapted than in the other species of reptiles, for the reception of aërial sounds.

In these various classes the inner surface of the membrane gives attachment to a slender trumpet like *ossiculum*, which is slightly expanded at the outer extremity, where fixed to the membrana tympani, whilst it is considerably enlarged at its inner end, in order that it might be accurately fitted to the margin of the fenestra ovalis

and its membrane; this delicate little bone, termed the *columella* from its shape, is no doubt correctly described as the rudiment of the stapes of higher animals (Plate V.). Two, or as some enumerate three, cartilages are united to the columella and the membrana tympani, probably influencing the movements of the bone; these are supposed to be rudiments of the malleus and incus, and some would add also of the orbicular. A muscle proceeding from above the tympanic membrane, is inserted into the bone; and it appears that the rudimentary malleus receives the attachment of two other muscular fasciculi.

The *Eustachian tube*, which runs inwards and forwards from the lower and forepart of the cavity, to the pharynx or mouth, is very large in all these classes. In the frog, it is little more than a prolongation of mucous membrane, and opens in front of its well-developed velum palati; it is so large, and so arranged, that when the capacious mouth is opened, the orifice becomes distended to a degree rendering it probable that sound reaches the tympanum through its channel: in the crocodile, the tube opens near the occipital condyle, and is thus protected by its valvular pharynx; in birds this *canal* joins its fellow, and thus they form a common opening in the median line of the upper part of the pharynx, where it is deprived of cartilage. In the *cetacea* the tube is very large, and opens into the upper part of the blowing apparatus, where it is furnished with valves worked by muscles, by which contrivance the animal can prevent water from entering the tympanum; whilst air is freely admitted. By this arrangement the passage seems to become an accessory external Ear, receiving and conveying those sounds most important to the animal when floating upon the ocean's surface for the purpose of respiration. In this tribe a curious separation of the tympanum from the labyrinth exists, always in the early periods, and often throughout life; the tympanum being a bone rolled up upon itself; thus corresponding somewhat to the division of the petrous portion of the temporal bone in the human fœtus (Plate VIII.).

In mammalia the four ossicula auditus are completed, or three, if the orbicular be considered an epiphysis of the

incus; the *malleus* is attached to the membrana tympani, the *incus* to the malleus and to the orbicular, as well as to the parietes of the cavity: the *orbicular* intervenes between the incus and the *stapes;* which last extends inwards to the fenestra ovalis. These fanciful names were given

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PLATE V.

Fig. 1.— Transverse vertical section of the Cranium of the Owl. A. Cavity of the Cranium seen from behind. a. Tympana; b. Their communication through the medium of the Cranial Cells; c. Semicircular canals; d. Meatus externus; e. Membrana Tympani; f. Foramen Magnum.

Fig. 2. — Ear of the Turtle. a. Cartilage corresponding to the Membrana Tympani; b. Tympanum enlarged at both extremities; c. The long Columella; d. The Vestibule with its Membrane; e. Semicircular Canals.

Copied Views of Stapides and Columellæ. From Sir A. Carlisle's Plate.

Fig.		times magnified.	Fig.		times magnified.
3.	Hedgehog	4	15.	Kangaroo	4
4.	Mole	6	16.	Duckbill	4
5.	Musk Ox	2	17.	Goose (and its Cartilage)	2
6.	Elephant	nat. size.	18.	Egyptian Ibis (from a Mummy)	3
7.	Tiger	2	19.	Turtle (Testudo Midas) and its Cartilage	nat. size.
8.	Dog	3	20.	Gangelic Crocodile	do.
9.	Horse	2	21.	Turtle (Testudo Coriacea)	nat. size.
10.	Pig	3	22.	Frog (and its Cartilage)	2
11.	Marmot with its Pessulus	4	23.	Toad	2
12.	Seal	2			
13.	Porpoise	2			
14.	Walrus	nat. size.			

A. General form of the organ of hearing in the fowl. — a. Anterior Semicircular canal; b. External, and c. Posterior, coalescing; d. The Cochlea; e. Fenestra Cochleæ; f. Fenestra Vestibuli closed by the base of the Columella, g.

B. Internal view of the same, exhibiting the superior Canal, and — a. Cavity of the bony Cochlea.

C. The ear of the Frog; showing the Membrane of the Tympanum, the cavity laid open, and traversed by the Columella; also the Vestibule with its Otoconie.

Plate 5.

Fig. 1.

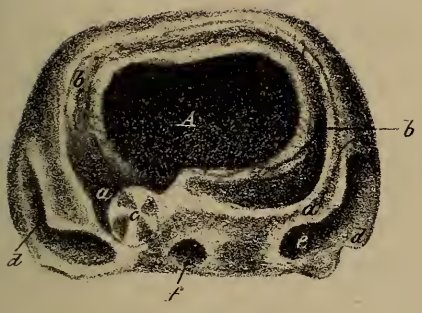
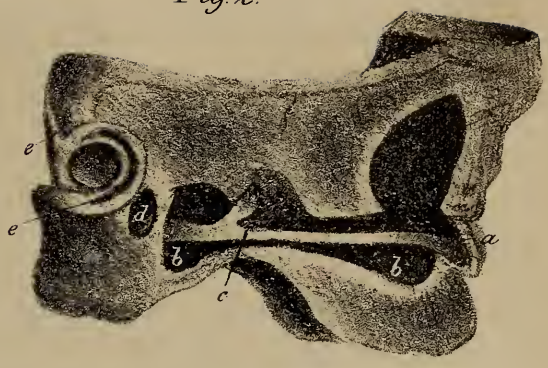
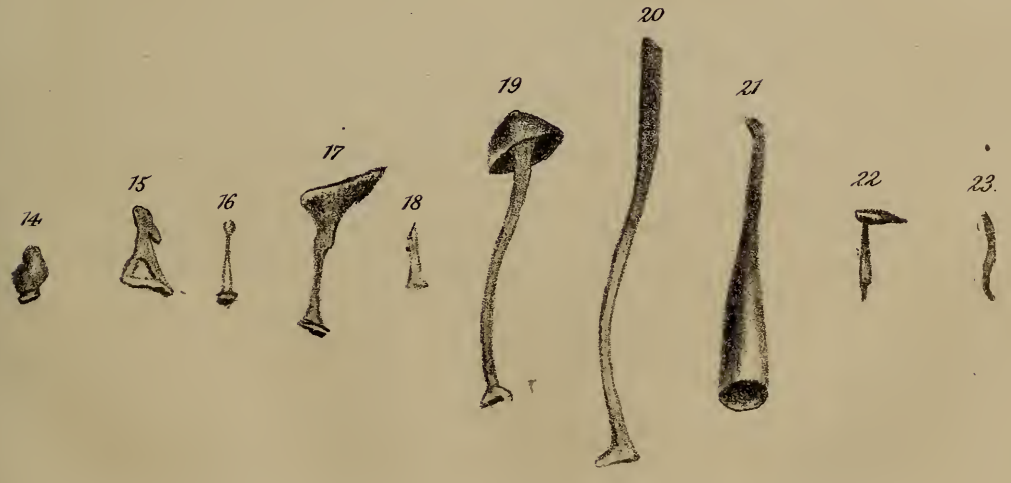


Fig. 2.





to the bones, partly from their supposed resemblance to the hammer, &c., and partly from their conceived function, it being imagined by the Antients that they actually struck against each other in the production of sound. The *stapes*, which is by far the most important of the whole series, is the first which is developed, and becomes gradually perfected in the classes of mammalia, as hearing is more required; thus, in the walrus it is broad, but imperforated; in the porpoise it is almost solid; it has two columns in the seal, and the opening between them gradually enlarges in the tiger, mole, and marmot to man (Pl. V., figs. 3 to 23).

To the malleus and stapes of mammalia, as to the single bone of inferior classes, are attached small muscles, which act through their medium to relax or tighten the membranes. In proportion as acute hearing is requisite, the tympanum is extended by communicating with the cells of the neighbouring bones; in man, with the mastoid; in the feræ, with cells at the base of the cranium, constituting the bullæ; in birds, with the cells of the cranium in general, and which are very large in nocturnal birds, as the owl. (Pl. V., fig. 1). The fenestra rotunda is oval in birds, and is not strictly round even in mammalia.

It is perhaps impossible, in our present state of knowledge, to understand the precise use of the tympanum and its appendages. That it is not necessary to hearing, is evident from its absence in the vast multitudes of animals noticed above; and further, from the fact of its nearly total destruction in mammalia, and particularly in man, being unattended with a corresponding diminution of the sense, audition being rather impaired than lost, and that not to any very great extent when the stapes remains attached and the labyrinth healthy. It does, however, appear to be necessary, by transmitting the slighter vibrations from the membrana tympani to the vestibule, to increase or to decrease the power or strength of sound; and hence the undulations of the atmosphere, being much more minute and indistinct than those of a denser medium, a tympanum is required to increase their power in terrestrial inhabitants. It is probable, also, that by the action of the muscles varying the state of tension

of the membranes of the tympanum and of the fenestra ovalis, and by the minute and rapid changes in the angles formed by the bones, a concord or unison may be produced, adapted to the sensorium which is to receive the impression; if this be true, this third division of the Ear becomes the *musical* portion. With a large external opening, admitting a constant current of air, evaporation must be so great, and the injurious contact of foreign bodies so certain, that an intervening portion between the labyrinth and outlet becomes necessary for the protection of the essential part; and a tympanum happily exists as a means of protection, and at the same time of perfection of audition. The Eustachian tube is doubtless serviceable as an excretory duct for the escape of any superabundant secretion, constituting an outlet corresponding to all other mucous sacs and canals. It also admits readily an ingress and egress of atmosphere, for the purpose of maintaining the membranes in a due state of tension, and of occupying the communicating cells; through it also, in some classes, as above stated of the cetacea, the sonorous rays may be conveyed to the tympanum, as indeed it is said to be in persons deaf from disease of the outer Ear; of this fact, however, there is considerable doubt, and the subject must be again referred to. The advantages derived from the communication of the tympanum with the cells of the cranial bones, appears simply to be an increase of extent, by which means an increased vibratory medium is obtained, producing a greater effect.

Section VI.

The fourth and last Division of the Ear is decidedly the least important, being merely an addendum for the reception and condensation of a greater number of sonorous rays than could otherwise impinge upon the membrane. A true *external Ear* exists only in the mammalia and the very highest reptiles, being unnecessary in a denser surrounding medium than the atmosphere. It is very correctly subdivided into the *meatus auditorius externus*, and the *auricula* or *pinna*. Both divisions are essen-

tially formed of very elastic thin fibro-cartilage, variously folded, and covered by a delicate and vascular reflection of the integument, which in some instances is particularly sensitive. The meatus is generally partly formed, in the adult Ear, of a projection of bone from the pars petrosa. The auricle is furnished with muscles; *intrinsic*, attached to the cartilage only to occasion the movements of its different processes; *extrinsic*, proceeding from the neighbouring parts to move the whole auricle upon the side of the head.

It has been seen that the simple Ear of the crustacea reaches the surface by the membrane of the fenestra ovalis, which is thus directly in contact with the circumambient fluid; this may be considered as an external Ear, though differing widely from an external appendage. In some few fishes, as the skate, a somewhat similar prolongation of the vestibule, as has been observed, opens beneath the integument, near the eyes, thus becoming almost external, and without doubt influenced directly by the surrounding fluid. Reptiles have a rudiment of an outer Ear, superadded to the tympanum, consisting of a thickened process of integument, defending the membrane only, and having no influence in the collection of sounds; though in the crocodile this integument is elongated into a rudimentary meatus when the creature is on land, and folded, by its valvular arrangement, upon the surface of the membrane during its aquatic sojourn.

Birds, having an internal apparatus a little more perfected than reptiles, and residing constantly in the atmosphere, are consequently furnished with a rudimentary external Ear: but as this, if a projecting organ, would interfere with the rapidity of their movements, it consists merely of a short membranous tube, varying in diameter and length, and placed between the os quadratum and os occipitis; it is rendered irregular by a fold, extending partly across it from the lower and posterior surface. This meatus is furnished with sebaceous follicles; and, according to De Blainville, its orifice is defended by two small cartilages, acted upon by the common cutaneous muscle. Around the orifice the feathers are neatly arranged, performing to a certain extent the part of an auricle, the

inferior in particular defending the aperture (Plate VI.). These feathers conceal the opening under ordinary circumstances, but are capable of being separated by the cutaneous muscle, at the will of the bird. This adaptation is admirably seen in the owl, whose nocturnal habits require the meatus to be unusually developed, and the folds to be so well marked, as in a slight degree to resemble the outer ear of higher animals (Plate VI., fig. 3). The ostrich and buston also are furnished with an external development resembling an auricle.

This appendage becomes particularly, but at the same time gradually developed in mammalia; thus in the cetacea, the meatus only exists, and is merely a long, narrow, curved tube, extending from the membrane, having a very small external aperture (Plate VIII., fig. 4). Its structure is in this class peculiar, the bony portion being deficient, and the tube formed of cartilaginous pieces overlapping each other; by this arrangement the length of the canal is capable of adaptation to the varying quantities of blubber which at different times surround this portion of the apparatus; thus, when much adipose matter is accumulated, the tube is lengthened, but when the animal becomes emaciated, it is shortened by the approximation and overlapping of the pieces, and thus is the opening always maintained upon the surface of the head.

Almost all the mammalia are possessed of a pinna, larger or smaller, consisting of a considerable development of the integument, containing, between its folds, portions

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PLATE VI.

Fig. 1. — The external ear of the Domestic Fowl, with its feathery covering.

Fig. 2. — The same, the feathery covering being removed.

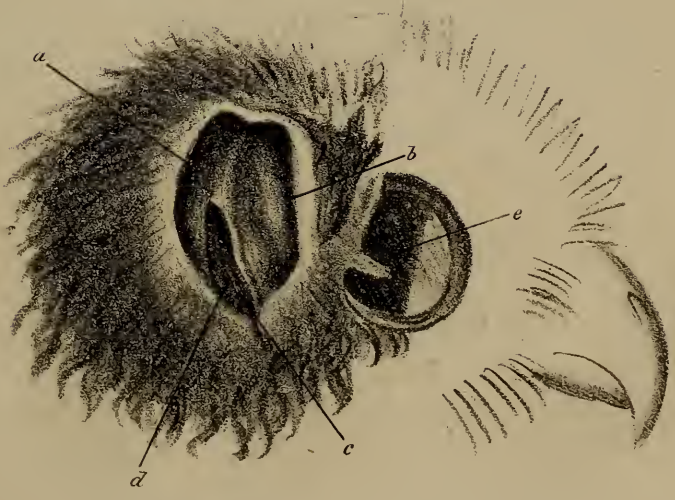
Fig. 3. — The external ear of a young white Owl, exposed by simply pressing the down aside. — a. Termination of the external skin surrounding the Orifice of the ear. b. The anterior flap or opercular fold of the ear. c. A part of the Tympanic, or quadrate bone. d. The Membrana Tympani. e. The Eye.

Plate 6.

Fig. 1.

Fig. 2.

Fig 3.



of fibro-cartilage, by which it acquires support, elasticity, and mobility. The cartilaginous portion of the meatus is divided into several pieces, which are united together and to the osseous portion, by cellular membrane, by the perichondrium, and by the reflected integument, thus increasing its mobility without impairing the unity of surface. The same separation is evident in the auricle of most animals, though in some, as in man, the divisions are incomplete. These portions are so disposed, that the inferior being moveable, defend more or less the external orifice; and the form as well as the size of the whole auricle varies considerably from the flat pinna of the simiæ and man to the prominent cornet of the ruminant, — to which reference will be particularly made in the description of the human Ear.

The size, shape, and direction of the concavity of the auricle are adapted to the habits of the animal. In timid creatures and those which are pursued, as the hare, rabbit, and ruminants in general, this structure, fully developed, is inclined backwards, towards the direction from which the sound of their pursuer usually proceeds, whilst at the same time, being very moveable, it may be laid so flat upon the head and neck, as not to impede the rapidity of their flight. In pursuing animals, on the contrary, as the carnivora, the auricle, which is small, is directed forwards, evidently with a view of guiding them to their prey (Plate VII., figs. 1 and 2). Many animals which are frequently rushing through thickets or brushwood, &c., are furnished with long pendulous pinnæ for the protection of the meatus. It has been long observed that the Ear becomes pendulous in proportion to the domestication of the animal, as is evidenced by the comparison of the tame and wild beings of the same species, as of the dog, pig, sheep, rabbit, &c., &c.; and the very long and pendent appendage of the spaniel of King Charles's breed is considered its greatest beauty, as marking its long uninterrupted lineage from a favourite and unmixed stock (Plate VII., figs. 3 and 4). This peculiarity is therefore esteemed a badge of slavery, the result of their dependance for support upon their master's bounty, rather than upon their own activity.

The intrinsic muscles are nearly similar throughout; they are arranged so as to elevate the prominent cartilages, and consequently to deepen the cavities, and to protect the meatus. The extrinsic muscles are much larger, performing the important office of turning the outer Ear towards the direction of the sound; these are anterior, posterior, superior, and inferior, in fact they quite surround the Ear, no distinct separation existing between them; they may also be divided into deep and superficial, the latter being apparently continuations of the general cutaneous muscle, the former proceeding from the neighbouring bones and fasciæ. Of these, anatomists have described six anterior, seven posterior, three superior, and one inferior, corresponding to the relative capability and necessity of movements in the different directions. Besides these, at least two muscles are attached to the external half of the meatus, to vary its diameter. It is found that man possesses the fewest external muscles, and the ruminant the greatest number.

The integument of the external Ear has nothing peculiar where covering the auricle excepting being thinner, and perhaps more than usually vascular; where lining the meatus the follicles are large and numerous, and their secretion being particularly waxy, they are termed *ceruminous*. This modification affords an increased security against the entrance of insects, and prevents an undue evaporation.

PLATE VII.

Head of a Bull-frog (*Rana Pipiens*) *showing the very large Membrana Tympani, a. a.*

Fig. 1. — The head of a black Wolf, with the ears directed forward, as in all predaceous animals.

Fig. 2. — The head of a rabbit, exemplifying the direction backwards of the ears of fugacious animals.

Fig. 3. — The head of a lopped-eared Rabbit, and

Fig. 4. — Portrait of a Spaniel, — both showing the effect of domestication and breeding in modifying the ear.

Plate 7.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

The *uses* of the fourth division of the Ear are evidently to protect the tympanum and especially its membrane; to collect a greater number of the sonorous rays, and to condense them towards the meatus, — which, by its oblique, and in some instances tortuous course, increases their power by reflection from its walls, and directs them somewhat to a focus upon the membrane.

It has occurred to the writer, and, without any communication upon the subject, likewise to a friend, while dissecting the ear of the porpoise,— that the external ear of the Cetacea does not serve the usual purpose above stated; but that the sonorous waves are conducted along the Eustachian tube into the cavity of the tympanum and the large hollow bone, which is peculiar to these animals, and there excites the vibrations of the small bones, the tube thus becoming functionally the external ear; — and that the meatus auditorius externus performs the office of the Eustachian tube of other classes, by admitting air, or perhaps in this instance water rarefied by the temperature of the animal, to counterbalance the pressure within, and occasionally to assist in producing the vibratory movements of the membrana tympani. This opinion is deduced from the anatomy of the organ, and from the habits of the creature. It will be seen, upon reference to the sketch of the Whale's ear, copied from that of Sir Everard Home, and to that of the porpoise (Plate VIII.), that the meatus is particularly small, tortuous, and long; that the membrana tympani is convex externally, and concave within, exactly opposed to that of other mammalia; that the malleus is not attached to the membrane directly, but indirectly to it and the concave bone, by a triangular membranous ligament; that the other attachments of the bones are as ordinarily found; and that the Eustachian tube which communicates with the blowing apparatus is especially large. These anatomical arrangements would seem to indicate that the ossicula could oscillate to a greater extent than that induced by the membrane; that their movements may be facilitated by the large volume of air contained in the concave-bone; that the membrane may vibrate from within; and that perhaps its most important use was to

protect the tympanum. These probabilities are much strengthened by the habit of the animal reposing so near to the water's surface, that the Eustachian tube has a direct communication with the atmosphere at the same time that the external meatus is submerged; a situation in which the creature has the greatest necessity for acute hearing, and one which it is obliged often to seek for purposes of respiration. The weight of this opinion is increased by the somewhat similar suggestions of the late Sir Everard Home.

PLATE VIII.

Fig. 1. — Internal View of the Tympanum and Cochlea of the Whalebone Whale. a. Internal Surface of the concave bone. b. Fatty case in which it is enclosed. c. A convexity covered by a thin ligamentous Periosteum, the fibres of which are radiated, and connect the Membrana Tympani as well as the Membranous fold, f, to the bone. d. Hollow formed by the Membrana Tympani. e. The external Surface of the Membrana Tympani. f. The membrane stretched across from the Concave bone to the Malleus, g. h. The incus; i, the Stapes; k, the Cochlea. l. The Auditory nerve; m, the bone connecting the petrous portion to the skull.

A. Malleus.
B. Incus of the Whale.
C. Stapes.

Organ of Hearing in the Porpoise.

Fig. 2. — a. Portion of the bone containing the Vestibule; b, acoustic nerve; c, portio dura; d, cavity of the Tympanum. e. Malleus; f. Incus; g. Stapes. h. Inner surface of the Membrana Tympani. i. Muscle and ligament connecting the membrane to the Malleus. j. Muscle of the Malleus.

Fig. 3. — Upper portion of the bone removed.

D. Meatus Auditorius Externus, dissected out.

Plate 8.

Fig. 1.

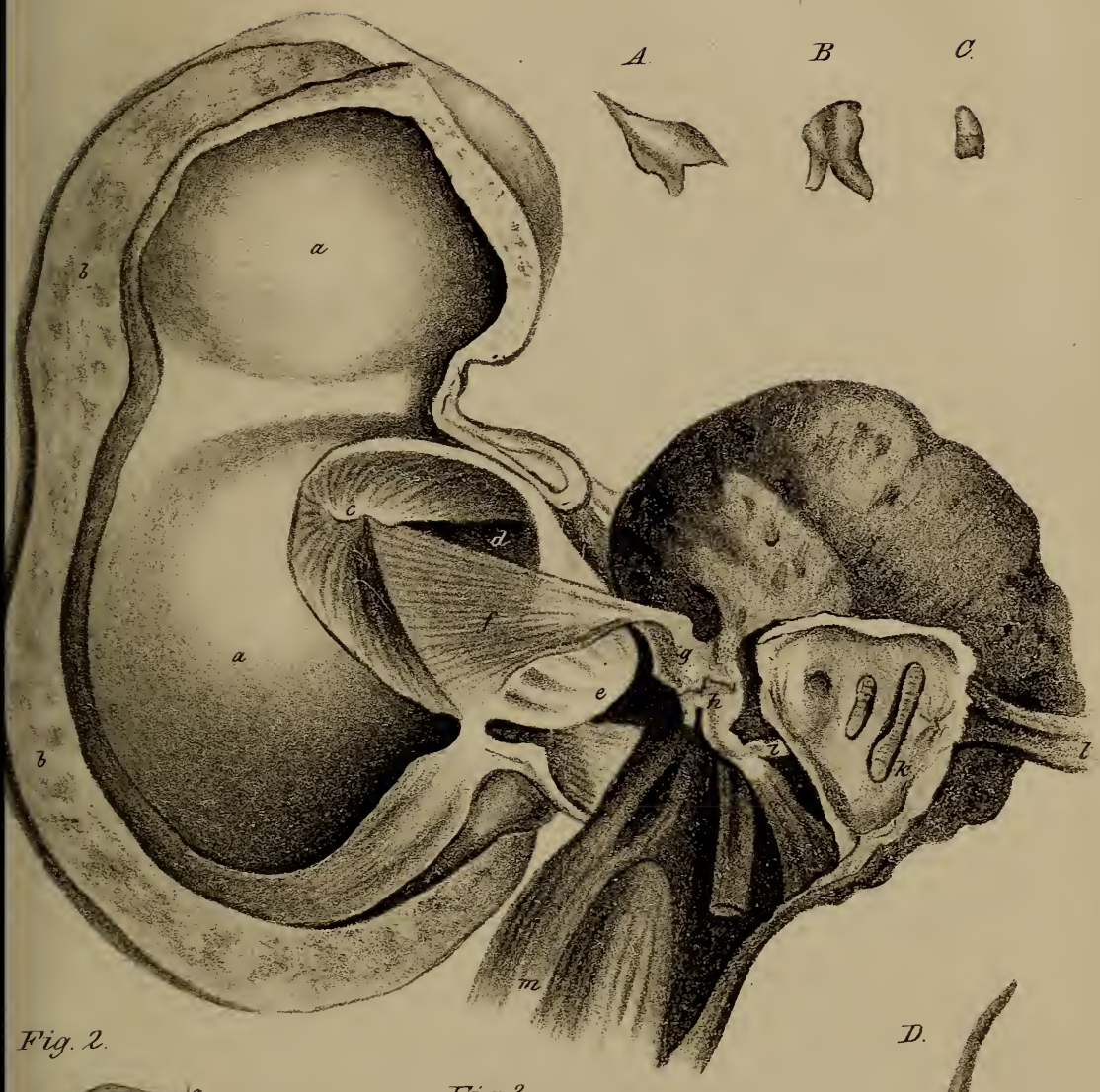


Fig. 2.

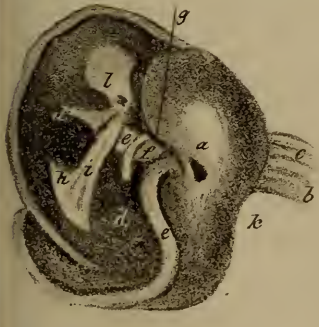


Fig. 3.

D.

CHAPTER II.

ANATOMY OF THE HUMAN EAR.

In treating this division of our subject it is purposed to reverse the order hitherto observed, according to which the most important part of the organ was first described, and subsequently the least essential; and to consider, in the manner found in the schools to be the most convenient, the various structures as they appear in the process of dissection.

Section I.

The Ear is correctly enough divided into three parts, the *external, the middle, and the internal Ear.* The first, including the *auricle* and *external auditory canal.* The second, *the tympanum and its appendages,* — and the third, *the labyrinth,* and the *aqueducts.* From the general history of the Ear which has already been given, it would appear to be more philosophical to make a fourth division, even in the human organ, by arranging the labyrinth under the two heads adopted by comparative anatomists.

Section II.

The External Ear (Plate IX., fig. 1), takes its denomination from the circumstance of its situation upon the side of the head, thus becoming an external feature; the term, however, includes the entire portion placed external to the membrana tympani, part of which is concealed; hence, the division into *auricula,* and *meatus auditorius externus* is very justifiable.

The *Auricle* (*Auricula*) is the fibro-cartilaginous expansion covered by integument, by which, as well as by

muscles and cellular membrane, it is attached between the mastoid process, and root of the zygoma of the temporal bone, partly overlapping the former, and ascending upon the posterior part of the temple. It is sub-divided into the *pinna*, and the *lobus;* the former being the superior fibro-cartilaginous portion, the latter the inferior fleshy appendage.

The Pinna constitutes by far the chief part of the auricle; it is furnished with elevations and processes, and corresponding depressions, so arranged as to form a concavo-convexity; the concavity being superficial and well adapted to receive sound, is termed the *concha*, and to this the rest of the auricle is subservient. The margin of the pinna is folded outwards, forming an elevation, and from its surrounding the rest of the organ is named *helix;* it commences above the centre of the concha, which it divides into two unequal portions, and then proceeding forwards and upwards, passes backwards on the superior margin, and descending along the posterior edge terminates in the lobus. The *anti-helix* is so called in consequence of its situation on the inner border of the helix. It commences by two crura behind the anterior part of the helix, above its crus, and below its upper edge; the inferior process forms the superior boundary to the concha, whilst the two crura, by their union, form a considerable prominence, which, constituting the posterior wall of the concha, descends to the *antitragus*. The groove which is necessarily formed between the helix and the anti-helix, has received the names of *cavitas*, or *fossa innominata*. The oval depression between the crura of the anti-helix has been called the *scapha*, *fossa navicularis*, *fossa ovalis*, &c.; indeed, the names given to the two depressions have been frequently confused. The lower part of the concha is defended by two interesting processes, the *tragus* and the *antitragus*. The *tragus*, fancifully named from the circumstance of its being furnished with a few short hairs for the purpose of further protection, constituting a far-fetched resemblance to the hide of a goat, is placed in front of the meatus and projecting outwards and backwards, conceals under ordinary circumstances that opening. The *antitragus* is a

smaller prominence, placed behind the orifice opposite to the tragus, projecting outwards and slightly forwards, it receives the termination of the anti-helix. These two bodies, being united below, form the inferior boundary of the concha, and being moveable will have, in quite a natural state, considerable influence in protecting the meatus. The concha becomes deeper and narrower from above downwards, and at its lower and fore part, behind the tragus, is placed the orifice of the meatus, somewhat contracted by its cartilaginous border.

In a perfectly natural condition a few pale muscular fibres are found attached to these prominences, for the purpose of still farther elevating them, in order to deepen the cavities, and thus to render them better adapted to conduct the sound to the meatus; in the Ear of the civilized being, in consequence of the mode of dress, and acute listening to distant sounds not being so frequently necessary, these muscles are so rarely used, that a little thickened fibro-cellular membrane is all that can generally be found. They are indeed hardly more developed in uncivilized tribes, being under all circumstances merely rudimentary.

1st. The *Tragicus* proceeds from the inferior edge of the tragus, runs along its outer surface to its upper margin, and sometimes reaches the edge of the helix. When developed this muscle will draw the tragus forwards, and thus uncover the meatus.

2d. The *Antitragicus* proceeds from the outer surface of the upper margin of the antitragus, to the inferior edge of the anti-helix. It will approximate these two portions of cartilage, and draw the antitragus a little outwards and backwards, assisting in opening the meatus.

3d. *Helicus Major* lies upon the external surface of the anterior portion of the helix, extending from its inferior extremity to its superior curve backwards, where separated from the head. *Use*, to draw the concha a little backwards and downwards, and to deepen the cavitas innominata.

4th. *Helicus Minor*, the smallest of the muscles, is posterior to the major; lying upon the horizontal commence-

ment of the helix, it passes forwards to its rim. The action is to draw the helix slightly downwards.

5th. *Posterior vel Transversalis Auris* is placed on the posterior convex surface of the concha; it is the largest muscle, and runs across from the anti-helix to the fossa scaphoides. It deepens and enlarges the concha. Mr. Tod has described two other muscles, *obliquus auris*, and *trago-helicus*. Quadrupeds, whose tragus and anti-tragus are well developed, are furnished with a powerful *tragico-antitragicus*, which approximates these two bodies and closes the meatus.

The *Lobus* is the fibro-cellular and somewhat fatty inferior appendage to the pinna; it hangs below the helix and antitragus, of which it resembles a continuation, and varying considerably in size in different individuals; it is frequently lengthened downwards to a degree of deformity by the weight of supposed ornaments. It does not appear to be of further use than to complete the auricle.

The fibro-cartilage of the pinna is highly elastic, and is formed of several pieces, which, having slight fissures between them, are firmly united together by condensed cellular membrane, constituting the *intrinsic ligaments;* the cartilage is particularly prominent where the inferior extremities of the helix and anti-helix unite, and here the lobus is appended. The skin of the auricle is thin and very vascular, receiving its vessels from the *posterior aural artery*, and by means of the *anterior aural*, from the *temporal;* its nerves are also tolerably abundant, being derived from the *portio dura* and from the *superior cervical plexus* by means of the *auricularis magnus*. The lobus is, fortunately for the custom of ear-boring, less sensitive than the pinna. The skin becomes gradually thinner from the margins to the meatus, where it approaches the character of mucous membrane. The high organization of the skin well capacitates it for resisting the influences of variations of climate to which it is so much exposed. The auricle is fixed to the neighbouring parts by short strong cellular membrane, which have been termed the *extrinsic ligaments*, as well as by the skin and muscles.

The extrinsic muscles consist of three sets of pale fibres, — 1st. *Attollens Aurem* is the largest muscle, yet very thin, of triangular form, with a rounded base; it arises from the centre of the lower edge of the tendon of the occipito-frontalis, and partly from the temporal fascia; the fibres converging terminate in a short tendon, and are thus inserted into the upper and posterior part of the pinna, behind the scapha. This muscle will raise the auricle, particularly during the action of the occipito-frontalis.

2d. The *Retrahentes Aurem* are always two, and sometimes there are three slips placed above each other, often well marked; they arise from the outer and anterior surface of the mastoid process, sometimes connected with the long muscles there attached; they pass directly forwards and are inserted into the posterior surface of the concha, near to the auditory opening, by short tendons. *Use*, to draw the auricle backwards, and to dilate the concha.

3d. The *Anterior Auris* is rarely to be seen in the European, its situation being merely indicated by a band of strong cellular membrane; when present, it arises from the root of the zygoma, and proceeds backwards and slightly downwards, to be attached by a short tendon, to the fore and lower part of the commencement of the helix. It will carry the auricle forwards and a little upwards.

The motions of the external Ear are nearly lost to the civilized being, from the same causes that have interfered with the development of the intrinsic muscles, so that the movements that are produced by some persons, can generally be accomplished only by contracting at the same time the occipito-frontalis; some few individuals have, however, possessed this power, and among others it has been so recorded of Albinus: uncivilized tribes enjoy this capability to a considerable extent. The exact shape and form of the auricle vary in individuals almost as much as those of the more prominent features; and it is interesting to notice that its variations extend to whole nations, and that in proportion to the advance of civilization, it has been observed to be smaller, more compact, and

oval, assuming the appearance to which the idea of beauty is attached; whereas, in the savage races, it is large, prominent, and somewhat pendulous, possessing a degree of mobility: thus corresponding to the general increased development of the organs of external sense, as contrasted with the diminished extent of mental capacity.

Some writers on acoustics have declared the shape of the auricle to be well adapted to receive and concentrate the sound, and to direct it to the meatus. It is said, that from this circumstance, "the first Dionysius of Syracuse had constructed a subterraneous cave in a rock, in the form of the human Ear, which measured eighty feet in height and two hundred and fifty in length; the sounds of this cave were necessarily directed to a common tympanum, which had a communication with an adjoining room, where Dionysius spent the greatest part of his time, to hear whatever was said by those whom his suspicions and cruelty had confined in the apartments above."

The *Meatus Auditorius Externus*, (Plate IX., fig. 1,) the narrowed part of the acoustic cornet, is a tube, partly osseous, partly cartilaginous, extending inwards from the lower and fore part of the concha to the *membrana tympani;* it may be defined as a reflection inwards of the fibro-cartilage. It is about an inch and a quarter in length, rather more than less; about a quarter of an inch in the transverse diameter, and a little more in the perpendicular direction, its section being oval. Its course is slightly curved, being at first forwards and upwards, then downwards and a little backwards, so that its concavity looks obliquely downwards and forwards; the inferior wall is longer than the superior, accurately corresponding to the oblique position of the membrana tympani; the dimensions of this tube vary, it being a little contracted at the orifice, still more so in the centre, which is the narrowest part, and again at the membrane. The *cartilaginous portion* forms rather more than half the meatus, but does not constitute a complete tube, being separated into several portions, which consequently possess some degree of motion upon each other; the cartilage is particularly deficient at the upper and outer part,

where the tube is completed by dense fibrous tissue; it is ultimately united to the irregular bony edge of the osseous portion by dense cellular membrane, in addition to the dernal lining. Some anatomists have considered that these fibrous connexions are partly muscular, which opinion appears to be unfounded. The *bony part* of the auditory canal consists of the *processus auditivus* of the temporal bone, which is completely developed in the adult, but is merely an osseous ring in the fœtus, at which period the entire length of the meatus is fibro-cartilaginous and membranous, corresponding to the structure in the lower mammalia. This bony portion is gradually increased to the adult age, when it constitutes rather less than half the meatus, and projects between the mastoid and vaginal processes, the latter assisting in forming its anterior wall, and in giving the obliquity alluded to above. The *perichondrium and periosteum* are continuous, and passing over the fibrous connexions of the portions of cartilage and the bones, perfect the tube. The meatus is lined by a reflection of the skin, here so modified as to assume partly the characters of a mucous membrane, and which is also accurately adapted to the external surface of the membrana tympani, resembling the arrangement we have noticed in reptiles. The lining membrane is peculiarized by its great delicacy, which becomes remarkable in the osseous portion; by the soft and fine downy capilluli, which exist throughout the whole tube, but do not extend upon the tympanal membrane, and by which it retains its cutaneous character; and, lastly, by the great number and large size of its follicles, which are occupying the subjacent tissue. These glands, which are chiefly confined to the outer half of the meatus, send their ducts obliquely through the membrane, to open upon its surface; their secretion differs from common mucus, being thick, yellowish, viscid and inflammable, bitter, and containing an oily fat, albumen, colouring matter, and a peculiar animal matter, thus having something the appearance of wax; it has been named *cerumen aurium*, the follicles themselves being consequently called *glandulæ ceruminosæ*. The cerumen, by its inspissation,

will prevent too rapid an evaporation, ensuring a moistened condition of the surface, thus preventing too great a degree of reflection of the sonorous rays; and it will especially interfere with the encroachments of insects, being probably poisonous to them, as well as preventing their movements by its tenacious principle. The lining membrane is also furnished, at the outlet of the meatus, with numerous short hairs, which in advanced age are long and strong enough to project considerably beyond the tragus. The hairs protect the tube against the entrance of small insects, at the same time that, by entangling among them a layer of warmed air, they prevent the too sudden transition from heat to cold, in some manner performing the office of the respirator.

The meatus auditorius externus receives the sound, concentrated by the auricle, and conveys it to the membrana tympani; but that is not all; it is a well-seasoned wind-instrument, and reflects the rays from its parietes, by which their power is increased and in virtue of its peculiar obliquity and shape, without a doubt, it forms them into a focus, which falls upon the membrane with much increased influence. It has been seen that many mammalia have probably two muscles to enlarge its capacity, and it is suggested by Richerand, that the partially deaf man, by opening his mouth and advancing the condyle of the lower jaw, may also increase the diameter of the tube, for the purpose of transmitting more freely the sound. Through the arrangement of the external Ear, the middle is securely placed deeply in the cranial bones, and maintained in the moistened condition so necessary to its functions.

Section III.

The *middle division of the Ear*, consists of the *tympanum* and its *appendages*, namely, the *membrana tympani*, *the four ossicula auditus*, with their *ligaments and muscles*, the *Eustachian tube*, and the *mastoid cells*. (Plate IX., figs. 1, 2, 3, 4, 5.)

Plate 9.

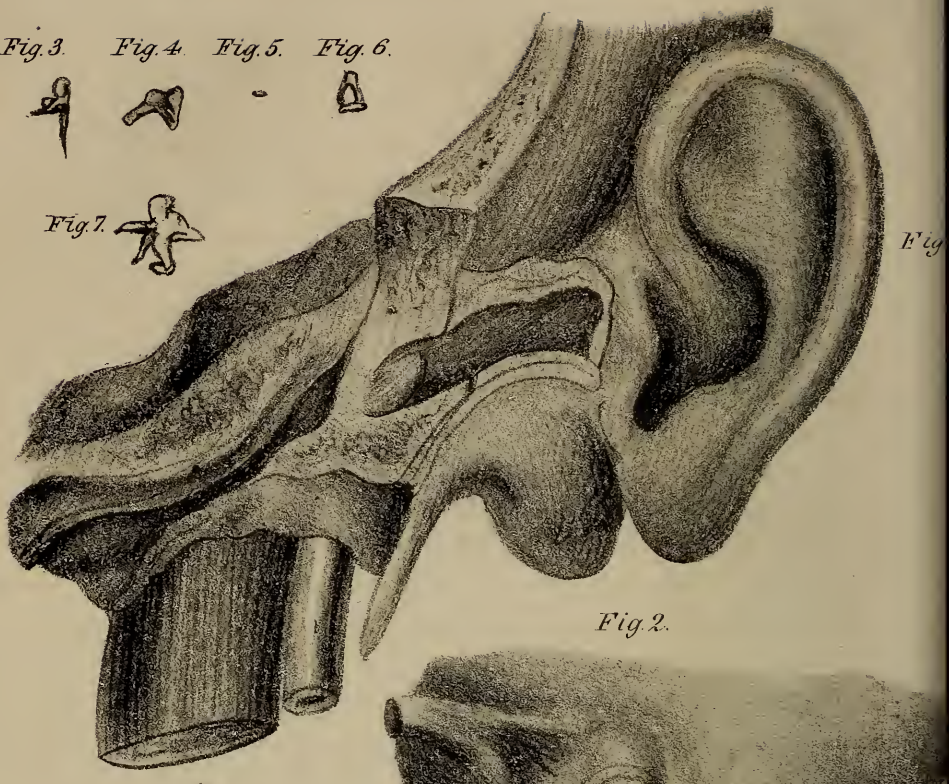
Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.



Fig

Fig. 2.

Fig. 8.

Fig. 9.

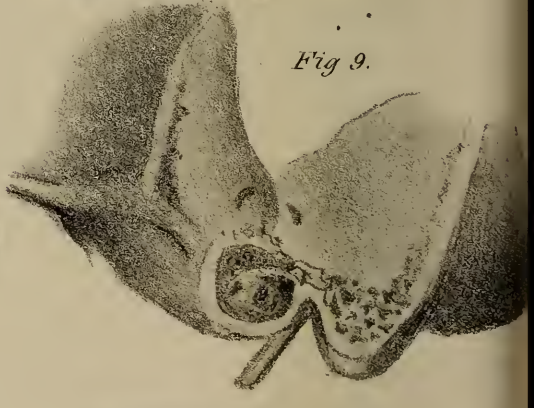
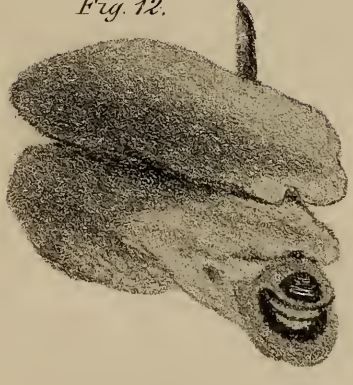


Fig. 11.

Fig. 10

Fig. 12.



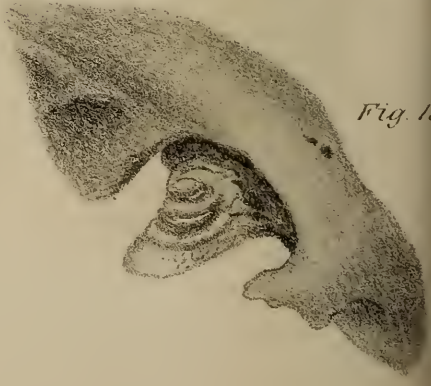


Fig. 13

PLATE IX.

The different Figures are faithful representations of recent Dissections of the Human Ear.

Fig. 1. — Exhibits the External Ear, Tympanal Membrane, and Eustachian Tube on the left side, the Middle and Internal Ear being necessarily out of view. A portion of the Squamous Plate; — the Mastoid Process; — and the Styloid Process of the Temporal Bone; — the Carotid Artery; — and Internal Pterygoid Muscle are depicted. On the Auricle are represented, the Helix, Antihelix, Cavitàs Innominata, Scapha, Concha, Tragus, Antitragus, Lobus. In the External Auditory Meatus, the Cartilaginous and Osseous Portions, with a considerable part of the Outer Surface of the Membrane of the Tympanum. The Eustachian Tube, which is laid open, has its Tympanic Osseous Portion narrow, and its Pharyngeal Cartilaginous Portion much expanded.

Fig. 2. — External Surface of the left Membrana Tympani, with its Blood-vessels; from a child about four years old.

Fig. 3. — The Malleus. 4. Incus. 5. Orbicular. 6. Stapes.

Fig. 7. — The Ossicula Auditus in connection with each other.

Fig. 8. — A lateral view of the Internal Surface of the left Membrane of the Tympanum with the Ossicula *in situ*.

Fig. 9. — Inner Wall of the Tympanum, with the Fenestra Ovalis, Promontory, which conceals the Fenestra Rotunda, and the communication with the Mastoid Cells: above the Tympanum are Sections of the Semicircular Canals.

Fig. 10. — The Right Labyrinth dissected out of the Petrous Portion, and unopened, exhibiting the Fenestra Ovalis, and the Fenestra Rotunda. — The Promontory. — The Superior, and Posterior, and External Semicircular Canals. — The Cochlea.

Fig. 11. — The same laid open, showing the two Membranous Sacs in the Vestibule, the Membranous Canals, and Membrane of the Cochlea with the Lamina Spiralis.

Fig. 12. — A lateral view of the Cochlea, showing the Spiral Canal divided into the two Scalæ by the Spiral Lamina.

Fig. 13. — Another view of the left Cochlea, showing the communication of the Scala Vestibuli with the Vestibule, and the termination of the Scala Tympani at the Fenestra Rotunda.

The *Tympanum* is a cavity situated in the outer and rather posterior part of the petrous portion of the temporal bone; irregular in shape, with the antero-posterior diameter rather the longest, and about half an inch in extent, while the transverse, crossed by the ossicula, is the shortest. This cavity is bounded externally by the *membrana tympani*, and internally separated from the labyrinth by an *imperfect osseous* plate, which is perforated by the *fenestra ovalis* and *fenestra rotunda;* it communicates at its lower and fore part, with the pharynx by means of the *Eustachian tube*, and at the upper and back part with the *mastoid cells*. The whole is accurately lined by mucous membrane, continuous with that of the digestive and pulmonary apparatus, and which also extends into the cells.

The *Membrana Tympani* (Plate IX., figs. 1, 2, 3) merits the especial attention of the Surgeon as it is constantly interested in diseases of the Ear. It is nicely fitted into a groove in the outer part of the pars petrosa, which with it forms the boundary between the auditory canal, and the cavity of the tympanum; the membrane is ovoid, the broader extremity being above, and the greater diameter, which is rather less than half an inch in extent, being perpendicular; it is inclined with considerable obliquity from above downwards and inwards, the lower edge being thus internal to the upper; the *outer surface*, which is directed a little forwards as well as downwards and outwards, forms with the inferior surface of the auditory canal, an angle of about 45°. This external surface is concave, having a conical depression usually situated a little below the centre, although the author has occasionally found it above, but never exactly in the middle. The *inner surface* is the exact reverse of the external, being convex with a corresponding conical eminence, to give attachment to a process of the malleus, and is inclined inwards, upwards, and a little backwards. This important membrane presents a bright silvery appearance more or less distinctly fibrous, and particularly upon the inner surface, the fibres converging from the circumference to the central depression. Vest and Wittman of Vienna have repeated the almost forgotten opinion of Rivinus

that the membrane is normally perforated, which assertion is certainly not correct, for in a healthy condition it constitutes a complete septum. Various opinions have been entertained of its structure; all authorities, however, agree, that it is covered externally by a continuation of the lining membrane of the auditory canal, though most probably it is only furnished with a reflection of the epidermoid layer, and that internally it is lined by the mucous membrane of the tympanum. The positive existtence of a proper membrane between the two reflections is not yet determined; some anatomists even now denying the presence of such a structure, whereas others, adopting the opinion of Sir Everard Home, which however was founded rather upon the dissection of the Ear of the elephant, than of that of man, declare it not only to exist, but to be in its nature a very active muscle capable of great variations of tension and relaxation.

The most careful examination does not afford evidence of such a structure in the human subject, nor have muscular fibres been seen by some of the most expert anatomists, either in the cetacea, or in the horse; and as Sir Everard Home has in other instances mistaken a fibrous structure reddened with blood-vessels for muscle, and as physiology leads us to believe that no advantage can be gained by such an arrangement in the membrana tympani, the conclusion may fairly be drawn, that this excellent comparative anatomist was in this instance deceived. Most Dissectors allow that an independent fibrous membrane does exist, and that it is not merely a thickening of the mucous surfaces; the outer reflection may be easily separated from it, whilst the inner is very thin and firmly attached.

The membrana tympani is very well supplied with blood; the *stylo-mastoid branch of the auricular artery*, and the *ramus tympanicus of the internal maxillary* form a coronary vessel around the osseous margin, from which twigs run to the centre, thus presenting an arrangement which has considerable resemblance to the blood-vessels of the *iris*. It receives also minute filaments of the nerves, from the *tympanic plexus*, probably chiefly supplied from the *chorda tympani*.

The *uses* of the membrani tympani, are to protect the cavity and consequently the labyrinth; to vibrate in obedience to the impression produced by the sonorous waves striking upon its external surface, and to transmit such vibrations to the malleus.

The *inner wall* of the cavity of the tympanum (Plate IX., figure 5), is rendered irregular by the *promontory*, the *fenestra ovalis* and the *fenestra rotunda*. The *promontory* is a projection of bone, forming nearly a third of the whole surface, situated a little below the centre; it is not solid as its name would imply, but is a mere shell, constituting internally the parietes of the enlarged commencement of the *scala tympani*. It is interposed between the two fenestræ, and projecting backwards, overlaps and defends the fenestra rotunda; upon its surface grooves are observed, which contain the nervous filaments, constituting the tympanic plexus.

The *fenestra ovalis* is placed in front and above the promontory, and below a projection formed by the *aqueduct of Fallopius;* its long diameter is almost transverse, but has a slight obliquity downwards and backwards; the inferior margin is a little elevated, and thus the oval is not perfect. In the dried bone the oval opening leads into the vestibule, but in the recent subject is closed by a thin fibrous membrane, upon which the base of the stapes is accurately fitted, the result of which must be that the motions of that bone are communicated to the membrane, and thence to the fluid in the vestibule.

The *Fenestra Rotunda*, situated behind and below the promontory, is directed backwards in such a manner as to be nearly concealed: it is rather triangular than round, partaking of both shapes, and leads into the scala tympani of the cochlea; in the natural condition this opening is also furnished with a membrane, described by Meckel as merely the lining of the tympanum, whilst Ribes and others more correctly regard it as corresponding in character to the membrana tympani, but of less strength. This structure, which is sometimes called *membrana tympani secondaria*, is set within the aperture formed by the bone, and appears more intimately connected with the cochlea than with the tympanum, though

covered by the mucous membrane of the latter. It will most undoubtedly oscillate, but whether in consequence of the influence of the air in the tympanum, or of the fluid in the cochlea, will be discussed hereafter.

The posterior wall of the tympanum furnishes the *eminentia pyramidalis*, which is an irregular little cone of bone, perforated for the passage of the stapedius, and placed on a level with the inferior edge of the oval opening; occasionally a process is continued from its apex, forwards and inwards, to the superior edge of the promontory, and its canal has even been traced downwards and backwards by M. Huguier, to communicate with the Follopian aqueduct. The pyramid appears to be only useful to give direction to the action of the muscle.

Around the superior and posterior margins of the cavity a slight elevation forms the wall of the aquæductus Fallopii, and marks its course; a small opening, the *apertura chordæ*, leads from it, behind and below the pyramid, giving passage to the chorda tympani.

The *mastoid cells* (Pl. IX., fig. 5) communicate with the tympanum at the upper and back part, through the medium of one large opening, or several small ones; the cells are a great expansion of the general diploe of the skull; and as the mastoid process varies in size, and its tables in the degree of their separation, the cells may be larger or smaller, more or less numerous. These excavations, as has been already stated, are lined by a continuation of the mucous membrane of the tympanum; and they may thus be considered as an enlargement of that cavity. It is imagined that the air, undulating in the cells, and the sound being as it were thus allowed to reverberate, its effect will be increased. Moreover, the cellular arrangement will certainly be effective in rendering the bone lighter, and at the same time increasing the surface for attachment of the mastoid muscles.

The *Eustachian tube* (Pl. IX., fig. 1) commences by a small aperture at the lower and fore part of the tympanum, whence it proceeds downwards, inwards, and forwards, and opens into the upper and lateral part of the pharynx, about a quarter of an inch behind the posterior opening of the nostril, and at the same distance above

its floor; its course is thus well adapted to allow the escape of mucus from the tympanal cavity. This tube is upwards of an inch and a quarter long, elliptical in shape, and slightly contracted from the tympanum to the cartilaginous portion, where it gradually enlarges to the pharynx, in which cavity it somewhat suddenly expands, having much the appearance of a straight trumpet with the mouth-piece removed. Its tympanic portion, which is osseous, and named the *Iter a Palato ad aurem*, is made up of the irregular extremity of the pars petrosa, and of the ala and the root of the pterygoid process of the sphenoid bone; the pharyngeal and longest portion is fibrous and fibro-cartilaginous, and, in correspondence with the bony portion, is more extensive on the inferior than on the superior surface; the fibro-cartilage forms the superior and internal walls, and the fibrous tissue the lower and external surfaces. The tube is lined by mucous membrane, which is continuous at one extremity with that of the tympanum, and at the other, where it assumes the fibro-mucous character, with the lining of the throat; it is abundantly supplied with mucous follicles.

Along the superior edge of the osseous portion of the Eustachian tube is a canal, separated from the tube partly by bone and partly by a fibrous membrane, transmitting the Tensor Tympani; the extremity of this canal forms a pulley, around which the tendon of the muscle plays, and is thus directed outwards to the Malleus.

The Eustachian tube, in the human subject at least, appears to be chiefly destined to permit a free ingress and egress of air to and from the tympanum; how far it is useful to allow recession, and thus to promote the undulations of the air, must be alluded to hereafter. It also affords a ready exit for the superabundant secretions of the mucous membrane.

The *Ossicula Auditus* (Pl. IX., figs. 3 and 4) are four in number in the young subject, and three at the adult period. They are named, as in the other mammalia, *malleus*, *incus*, *orbiculare*, and *stapes*, and form an irregular chain, stretching across the upper part of the cavity from the membrana tympani to the membrana fenestræ

ovalis, thus maintaining the communication between the external and internal Ears. The *Malleus*, not badly termed as it somewhat resembles a mallet, is furnished with a caput, cervix, processus gracilis, processus brevis, and manubrium. The *head*, which forms the superior part, projects above the level of the membrana tympani into a cavity termed the tympanic sinus; it is convex, and smooth upon its upper and outer surface, whilst upon its inner and rather posterior part is a concave articular surface, divided into two by a transverse ridge; these depressions are covered by cartilage, and are united to corresponding articulations on the incus. The *neck*, by which the processes are attached to the head, is short and contracted, and slightly marked by the attachment of muscles and ligaments. The *long or thin process* is nearly as long as the rest of the bone; it can rarely be separated from the skull in a perfect state in consequence of its delicacy; it proceeds from the neck in a curved direction forwards and a little downwards, and a fine point becomes attached to the inner margin of the tympanic ring, close to the Fissura Glasseri. The *short process* is thick and strong, and projects directly outwards, forming a right angle with the manubrium, leaving between itself and the neck a deep depression; it is united to the upper part of the membrane. The *handle*, which forms the bulk of the bone, descends from the cervix and processus brevis, being inclined a little backwards, though occasionally the Author has seen it forwards, but particularly inwards, so as to correspond to the obliquity of the membrane; it tapers to an inferior point, which is slightly enlarged and turned outwards to be articulated to the elevation of the membrana tympani, between the layers of which the manubrium is fixed.

The Incus, though something like an anvil, more nearly resembles a molar tooth; it has a corpus and two crura. The *body* is nearly square and flat, having superiorly a concavity, which is divided into two slight elevations by a deep fissure; these are covered by cartilage, and are directed upwards and forwards to be articulated to the head of the malleus; a most interesting double pulley-joint is thus formed. The *short crus* is much the

thicker, flattish on its anterior and posterior surfaces, becoming gradually smaller to an apex, it projects nearly directly backwards to be united to the edge of the mastoid cells by a well marked ligament. The *long crus* is much narrower, as well as longer, and becomes smaller to its point; it hangs downwards, a little forwards, and inwards, thus diverging from the manubrium of the malleus; the extremity is enlarged into a small button-like process, and turned inwards to be articulated to the orbicular.

Os Orbiculare or *lenticulare*, is a mere speck of bone, and is always a process of the long crus of the incus, in the adult Ear, and frequently in childhood; when it exists as a distinct bone, a minute concavity may be recognised upon its outer surface by which it is united to the long crus of the incus, and a better marked convexity upon its inner surface to be received into a depression upon the head of the stapes.

The Stapes very much resembles in shape the stirrup-iron, possessing a head, neck, two crura, and a base. The *head* is the external, very slight expansion, presenting a depression, by which it is articulated to the orbicular. The *neck* is the small portion between the head and crura, sometimes contracted, but frequently of the same size as the head, and is therefore often not described; it is always marked by the attachment of ligaments and a muscle. The *crura* pass horizontally inwards, diverging from each other, and become united to the base; the posterior crus is more curved, and consequently longer than the anterior, thus the bone of one Ear may be distinguished from the other. The *base* exactly corresponds in shape to the fenestra ovalis, but is a very little smaller, by which arrangement its motions will more perfectly influence the membrane; it is nearly a horizontal oval, being convex on its upper margin, and slightly concave on its lower, flat and smooth internally where lying in contact with the membrana fenestræ ovalis. The crura and base are grooved upon their opposed faces, to such an extent that their walls are transparent; this groove receives the triangular ligament to be further alluded to.

Are these ossicula articulated through the intervention

of ligaments proper? H. Cloquet says they are unfurnished with ligaments, and are held together merely by the common mucous membrane of the tympanum, which he seems to believe also constitutes the only periosteum they possess. The anatomists of this country, on the contrary, have usually described ligaments; and there can exist but little doubt that some of the folds of the membrane, are so strengthened as to merit this distinction; of these particularly may be mentioned the *triangular ligament*, occupying the space between the crura and base of the Stapes, and the *ligament* of the short crus of the Incus passing to the edge of the mastoid cells. So delicate and thin are the other ligamentous attachments, that a doubt may be justified as to the existence of more than mucous membrane; there are, however, usually enumerated, 1st. A ligament fixing the manubrium and short process of the malleus to the membrana tympani; it is very certain that this process of bone is placed between the mucous and proper membranes, and its union appears also to be strengthened by cellular tissue. 2d. A fine ligament tying the long process of the malleus to the edge of the bony ring of the tympanum. 3d. A synovial capsule reflected from the head of the malleus to the body of the incus; it is more than probable that this exists, as the outline of both bones is obscured until they have been cleaned; and as their surfaces are tipped with cartilage, considerable mobility is allowed between them; thus the articulation bears every analogy to a perfect joint. 4th. A synovial capsule between the long crus of the incus and orbicular, this mode of union, for reasons already stated, can only exist in the young subject, and most probably even then it is absent. 5th. A capsule articulating the orbicular to the head of the stapes, appears to be present. 6th, and lastly, a ligamento-mucous junction unites the base of the stapes to the membrane and margin of the fenestra ovalis, similar to that between the malleus and membrane of the tympanum.

These minute bones are furnished with four muscles, through the actions of which the membranes are affected. So imperfectly developed are some of these muscles, that many anatomists doubt the existence of more than one,

considering the others as mere ligaments, and Cruveilhier says, that the internus mallei can alone be clearly demonstrated, though he will not deny the presence of the others. Whereas Mr. Tod has described many additional ones, three being supposed by him to be attached to the incus; it is evident that in this instance folds of mucous membrane have been mistaken for muscular fibres.

The *Tensor Tympani*, or *Internus Mallei*, arises from the superior surface of the cartilaginous and bony portion of the Eustachian tube, and from the neighbouring edge of the petrous bone; it runs backwards and outwards along the upper surface of the tube, through the osseo-fibrous canal before mentioned, into the cavity of the tympanum; its well formed round tendon winds directly outwards round the margin of the canal as through a pulley, and becomes inserted into the inner surface of the commencement of the manubrium of the malleus, just below the long process. This muscle will evidently draw the bone inwards, and so tighten the membrane, increasing its internal convexity and its external concavity.

The *Laxator Tympani*, or *Anterior Mallei*, proceeds from the spinous process of the sphenoid bone, runs inwards and backwards through the fissura glasseri of the glenoid cavity, sends off a long and slender tendon to be inserted into the root of the long process of the malleus. This muscle will draw the malleus outwards and a little forwards, and thus relax the membrane, antagonizing the Tensor.

Levator Tympani, or *Laxator Minor*, is not always to be found, and when present, is very small; arising from the upper surface of the processus auditivus, it descends between the mucous and proper membrane of the tympanum, to be inserted into the processus brevis of the malleus. It will raise the bone and carry it outwards, consequently relaxing the membrane.

The *Stapedius* arises from one of the mastoid cells and bottom of the eminentia pyramidalis; it passes through the canal of the pyramid, and immediately becoming tendinous, advances to its insertion in the posterior edge of the neck of the stapes. This muscle will carry the

stapes backwards and roll the posterior edge of its base inwards against the membrana fenestræ ovalis, thus increasing its tension; it is generally supposed, however, to have more influence upon the membrana tympani by drawing the chain of bones inwards, and so assisting the Tensor tympani.

The mode of articulation of the bones is admirably adapted to increase the influence of the vibrating membrana tympani: few instances, indeed, of mechanical advantage more deserve the admiration of the physiologist. The malleus, connected by the whole length of its manubrium, is incapable of separation from the membrane, and must therefore receive its minutest motion; but that motion is increased by the bone resting upon the membrane, chiefly by means of the projections at the two extremities, the processus brevis and the curved enlargement of the point of the manubrium, by which arrangement a certain degree of rotation is allowed: this rotatory motion is modified, and the bone more firmly secured, probably even the vibration of the membrane itself to a certain extent limited, by the mode of attachment of the long process. The short lever which is formed between the manubrium and head of the malleus, will somewhat increase the motion. This increased motion is transmitted to the incus, which is articulated to the malleus with such an obliquity, that the centre of motion is through the middle of its body and short crus; the latter may be considered as an extension of the former, to secure the whole bone more firmly in its position, and at the same time, so far from impeding the movements, they are most likely increased by this arrangement; at all events th oscillations will hereby be steadied and more readily stopped. The long crus hanging and moving freely in the cavity will, in proportion to the length of its lever, still further increase the motion communicated to it from the body: its curved termination forms a most convenient attachment for the horizontal bones, which thus form almost a right angle with it. The orbicular and stapes by the lever, which they thus form, again augment the motions received, and convey them to the membrana fenestræ ovalis. Thus, then, the vibrations of the com-

paratively large membrana tympani, are not only condensed upon the small membrana fenestræ ovalis, but are importantly increased in their transmission through this interesting chain of bones.

The exact influence the muscles of the tympanum exert, in regulating the vibrations of the membranes and the bones, is not ascertained. The general opinion is, that they are voluntary, being supplied with nerves from the portio dura, and that the membrana tympani is tightened or relaxed at will, as the sound may be pleasing or discordant: more correct observations however show, that they all, and particularly the tensor tympani, received especial branches from the otic ganglion, besides twigs from the tympanic plexus, and thus they may be supposed to be involuntary, and to be acted upon sympathetically, through the medium of nervous connexion with the portio mollis: resembling the influence of the retina upon the muscular fibres of the iris. This forms an interesting problem for solution, probably both opinions are correct; as the muscles are supplied from the two sources, — from the voluntary system by the portio dura, and from the ganglionic by the chorda tympani, and the otic ganglion, — is it not probable that they may be of the mixed character, acting involuntarily when the acoustic nerve is over-excited, or when the mind is otherwise engaged, and attention not directed to the protection of the membrane and of the ear in general; and being influenced by volition, when the individual is desirous to increase or to diminish his mental perceptions?

Section IV.

The *Internal Ear*, or the *Labyrinth*, as it is termed from its complexity of organization, constitutes the *Ear proper* (Pl. IX., figs. 6, 7, 8, 9); the divisions hitherto treated of, being merely subordinate appendages. It contains the pulpy expansion of the acoustic nerve, to accommodate the requisite extent of which the labyrinth is formed of canals or tubes, curiously curved, and all communicating with a central enlargement, the vestibule.

These canals are formed in the internal portion of the pars petrosa, and are entirely concealed in the adult; whilst in infancy, this portion of the temporal bone being incomplete, a part of their outline may be distinguished. The osseous canals contain a membranous labyrinth, exactly corresponding to themselves, except in the vestibule, where some variety occurs: thus has this division of the Ear been arranged under the heads of *Osseous Labyrinth*, and *Membranous Labyrinth.*

It is therefore purposed to describe, first, the bony canals, and then to allude to the membranous.

The *Bony Labyrinth* is sub-divided with much advantage into the vestibule, the three semicircular canals, and the cochlea. The vestibulum occupies nearly the centre; the semicircular canals are placed behind and external; whilst the cochlea is in front and internal to the vestibule, so that the labyrinth is placed obliquely as regards the skull.

The *Vestibule* is situated immediately on the inner side of the tympanum, rather posterior to the centre, the two cavities communicating in the dried bone through the fenestra ovalis. It is an oblong excavation, rather larger than a decorticated grain of barley; and is bounded in front by the cochlea, behind by the semicircular canals, and internally, by a cribriform plate of bone, situated at the bottom of the meatus auditorius internus, through which one division of the portio mollis passes. An osseous ridge runs along the vestibule, partially dividing it into two foveæ or depressions; the posterior, which is the larger and oval, is termed the *fovea elliptica*, or *cavitas ovalis*, into this depression the semicircular canals open; the anterior and the smaller being somewhat semicircular is termed *fovea*, or *fossa orbicularis*, or *hemispherica;* it communicates with the cochlea; the posterior oval sulcus forms inferiorly a third, sometimes described under the term of *fovea sulciformis.* Besides the fenestra ovalis and the cribriform foramina already noticed, the vestibule has five openings at the upper and back part, from the semicircular canals; a larger one leading into the cochlea at the lower and fore part; and generally a small one at the posterior surface, which is the commencement of the aquæductus vestibuli.

The *Semicircular Canals* constitute the posterior and most extensive part of the labyrinth. Each canal forms at least three-fourths of a circle; the most extensive is the *superior*, *vertical*, or *anterior*, which passes transversely across the petrous portion: its convexity being upwards, forms an eminence on the superior wall of the bone; the anterior crus is enlarged into an ampulla, and the posterior uniting with the upper crus of the oblique canal, forms with it a common tube opening into the upper and back part of the vestibule. The *posterior*, *oblique*, or *inferior*, is next in extent; it occupies the posterior part of the pars petrosa, and is placed lengthways as regards the bone, with the convexity turned outwards; one crus being superior, communicates with the posterior of the vertical; the other crus being inferior, is enlarged into an ampulla, and opens into the lower and back part of the vestibule. This canal, which is sometimes called the posterior or inferior vertical, nearly completes a circle. The *external* or *horizontal* is the shortest and largest of the three, and is also placed lengthways, its convexity being outwards, and its two crura on the same level; the anterior crus forms a slight ampulla, and communicates with the vestibule, immediately below, and external to the opening of the vertical, while the posterior opens external to, and below the common canal. The canals are not exactly round, but flattish, and are about half a line in diameter, being a little enlarged at the extremities, independently of the ampullæ.

The Cochlea, named from its resembling a snail's shell, is the most intricate division of the labyrinth, of which it forms the anterior and outer part. When its walls are exposed without opening its interior, by cautiously filing away the petrous bone, it is seen as a well-marked pyramid, with the base opposed to the meatus auditorius internus, and formed by a cribriform plate of bone, perforated with beautiful regularity, for the admission of vessels and nerves; the apex, which is somewhat rounded, is inclined outwards and a little downwards, in such a manner that the whole structure is not quite horizontal. A little further removal of the bone will expose the outline of the tube. The cochlea is a spiral conical canal,

making two and-a-half turns round a central pillar; and as the pillar is a cone, the spiral tube is most extensive at its base, and becomes gradually and proportionally diminished both in length and diameter to its apex. The central pillar, which is termed the *axis*, — and in consequence of its supposed resemblance to the nave of a wheel, the *modiolus*, — is a hollow cone, its base formed by the lamina cribrosa, and its apex again a little enlarged, forming a second smaller cone, termed the *infundibulum*, the two are thus united by their apices. The base of the infundibulum is surrounded and formed by the apex of the Cochlea, which, when examined internally, presenting much the appearance of a dome, has been called the *cupola:* the walls of the pillar are extremely thin, and perforated, especially towards the base, by very many minute openings which transmit vessels, and particularly nerves, to the spiral tube.

Commencing at the inferior and posterior part of the base of the modiolus by a large opening from the vestibule, and from the inner surface of the promontory, the spiral canal makes its first, largest, and longest turn along the inferior to the anterior, and then the superior and posterior parietes to the second turn; whence it continues winding outwards to the apex, and the last half turn terminates under the Cupola,— the canal becoming gradually smaller as its extent diminishes. The spiral tube is subdivided into two scalæ, or gyri, by a septum called the *lamina-spiralis*, taking the same spiral direction; this septum is complete at the commencement of the canal, where it forms a part of the inferior and anterior wall of the vestibule, but is incomplete at the apex, not extending so far as the canal; it there terminates in an unciform process, *hamulus cochleæ*, beneath the cupola, beyond which the two scalæ uniting into one, form the *canalis scalarum communis*. The *Lamina Spiralis* is partly osseous and partly membranous; from the wall of the central pillar projects a spiral ridge of bone about one fourth or a third across the canal, and which consists of two plates, between which the nervous fibrils pass to the membrane; to this bony ridge a coriaceous fibrous membrane is attached, reaching to the inner surface of the

parietes of the canal and perfecting the septum; the membranous portion has received the name of *zona cochleæ.* The osseous portion is more extensive in the first turn than in the succeeding. From this arrangement it is readily understood that one scala opens into the vestibule, and is therefore named the *Scala* or *Gyrus Vestibuli;* and that the other, separated from the vestibule by the lamina spiralis, has its commencement immediately behind the membrane of the fenestra rotunda, by which alone it is excluded from the tympanum, and hence is called *Scala* or *Gyrus Tympani.* The scala tympani is the inferior, and throughout its extent the more capacious canal; its base especially presents an object of interest, as it may possibly at some future period lead to a better understanding of the use of the cochlea. (Pl. IX., figs. 8 and 9.) The lamina spiralis is here large, and runs backwards beyond the scala vestibuli, between the wall of the tympanum and the vestibule, to become attached to the margin of the fenestra rotunda internally, thus forming the parietes both of the vestibule and of the scala tympani; at this commencement of the scala tympani, the plate of bone common to it and the tympanum is enlarged outwards, forming the promontory already noticed, and consequently materially increasing the capacity of the scala, which will thus contain a little reservoir of fluid, influencing the degree of undulation and of the motion of the membrana secondaria — (membrana fenestræ rotundæ). The scalæ are often described, and perhaps correctly in reference to their physiology, as commencing from the vestibule, winding round the central pillar, turning back from the canalis communis round the hamulus cochleæ, winding back again to the fenestra rotunda. It has been suggested by Ilg and others, that the central pillar or axis is ideal, and that it is merely the inner wall of the spiral canal, resembling as it were a hanging stair-case with closed banisters, which appears to be merely a difference in description, for if we can imagine the closed banisters to be complete from the base of the flight of stairs to the termination, a shaft would assuredly be formed, similar to the axis of the cochlea; perhaps the term pillar does not

exactly convey the impression intended, for it can hardly be considered a centre of support for the spiral canal, but as being necessarily formed by the union of their inner parietes, as a means of supporting the nerves and vessels. Allusion to the great similarity existing between the arrangement of the scalæ of the cochlea, — their commencement, course, termination, and mode of union, with the stupendous shaft of spiral steps leading from Snargate Street to the heights at Dover, and down again, can hardly be refrained from; it would almost appear probable that the architect who planned that wonderful work, was acquainted with, and took as his model, this still more wonderful contrivance of the cochlea.

The aqueducts of Cotunnus, even at this day, by some physiologists, are esteemed of considerable importance in the production of hearing, whereas they appear, from the careful investigations of Ribes, to be merely osseous canals transmitting blood-vessels and lymphatics; they are two in number, the *Aquæductus Cochleæ*, which, proceeding from the scala tympani very near to the fenestra rotunda, passes backwards under the labyrinth, and perforating the bone, terminates by an irregular opening about the middle of the lower margin of the posterior surface of the petrous portion; in this course it enlarges and communicates with many smaller canals which issue from the cancelli. The *Aquæductus Vestibuli* proceeding from the inner part of the vestibule, near the common opening of the superior and posterior canals, perforates the bone in the concavity of the former, and descends to the posterior surface of the pars petrosa near the jugular fossa; this canal also enlarges in its course, and receives many smaller passages; it can sometimes be traced only as far as the cancelli around the vestibule, and some anatomists describe it as occasionally opening into the scala vestibuli. Cotunnus, and most anatomists after him, among whom may be mentioned Meckel, have described these aqueducts as being lined by a reflection of the membrane of the labyrinth, forming a communication between that membrane and the dura mater, by which it was supposed the fluid would recede during its undulations; they are, however, found to be entirely occupied

by vessels proceeding to and from the labyrinth and bone, the veins terminating in the internal jugular, and perhaps also the absorbents, and the arteries being derived from those of the dura mater. It is possible that the lymphatics may, by active absorption, prevent over accumulation of the fluid.

The *Aquæductus Fallopii* is misnamed, being an osseous canal for the purpose of transmitting the important portio dura, and protecting that nerve in its course; this passage is unconnected with the organ of hearing, further than by passing in its neighbourhood, and being perforated by some of its nerves. Commencing at the upper and inner part of the bottom of the meatus auditorius internus, the Aquæductus Fallopii passes outwards, at first a little upwards and forwards, then backwards and downwards, and lastly almost directly downwards to the *foramen stylo-mastoideum*, which forms its termination; in this course it is lodged between the external semicircular canal and the fenestra ovalis, surrounding the upper and back part of the tympanum. At its superior part it receives the *hiatus Fallopii* or *foramen innominatum*, a narrow canal on the upper surface of the pars petrosa, and which conducts the Vidian nerve to the portio dura. It is also perforated by several openings in its descent, which transmit the chorda tympani and other nerves to the tympanum.

The *Meatus Auditorius Internus*, through which pass the Portio Mollis, Portio Dura, Portio Intermedia, and Internal Auditory Artery, commences at the posterior surface of the petrous portion of the temporal bone; it passes outwards and forwards, is about half an inch in length, and less than a quarter in depth, and is terminated by an osseous plate, intervening between it and the labyrinth. This plate is divided into two unequal portions by a transverse ridge, the upper, and considerably the smaller portion, presents an opening at its anterior part which forms the commencement of the aquæductus Fallopii; and at its posterior part are numerous small foramina, through which pass the filaments of one division of the portio mollis to reach the superior semicircular canal. The lower and larger portion has also two

divisions, the anterior of which forms a very regular cribriform plate,— circle of foramina being within circle, to the centre, which is occupied by one opening larger than the rest; through these perforations passes a division of the nerve to the cochlea, the plate being in fact the base of the modiolus; the posterior division also transmits filaments of nerves to the vestibule, and to the ampulla of the posterior canal. The meatus is lined by a reflection of the dura mater.

The bony labyrinth is exactly lined by a very delicate, and highly vascular periosteum, which secretes the *Aqua Labyrinthi* or the *Perilymph of Breschet*, described by Cotunnus, and which covers also internally the membranes of the fenestra ovalis and fenestra rotunda. Upon the inner surface of this delicate periosteum, in the scalæ of the cochlea, the acoustic nerve is expanded, of a pulpy consistence, and is under the immediate influence of the fluid.

The *true Membranous Labyrinth* is contained in the semicircular canals, and in the vestibule (Pl. IX., fig. 7). The Membranous Canals exactly correspond to the osseous, except in being much smaller, and in projecting a very little into the vestibule before they communicate with each other. The vestibular portion of the membranous labyrinth is composed of two sacs; the larger and posterior, occupying the fossa ovalis, is termed the *Utricle* or *Sacculus Vestibuli*, and into it open the semicircular canals; it is, however, the opinion of some continental anatomists that the inferior crus of the posterior canal communicates with the smaller sac. It is worthy of remark that the canals near their Ampullæ lie, for a very short distance, upon the surface of the Sacculus before they open into it. The smaller sac is anterior and occupies the fossa hemispherica, it is sometimes termed the *Sacculus*, when the larger will be called the *Sinus* or *Alveus Utriculosus*. The smaller sac is certainly closed towards the cochlea, and Meckel and some others, even regard it as an isolated little pouch, being closed on every side, whereas other authorities consider it to communicate with the commencement of the posterior canal, and Dr. Roget in his Bridgewater Treatise, describes the two sacs

as freely opening into each other. It appears that the posterior surfaces of the sacs are adherent, by fine cellular tissue, to the periosteum of the vestibule, but that the anterior surface, where opposed to the fenestra ovalis and to the scala tympani, is free and surrounded by fluid.

The Membrane is very thin and of a whitish colour; upon it are expanded the pulpy extremities of the nerve, which are most abundantly spread over the ampullæ. When the nerves first reach the membrane they are fibrous, and then gradually assume a semimucous consistence. The membranous canals and vestibular sacs are completely distended with a thin serous fluid, resembling that contained in the osseous canals, and which is occasionally called the *Liquor Cotunni*, to distinguish it from the surrounding perilymph; though Cotunnus was not acquainted with the existence of the two fluids. Blainville has termed it "*Vitrine Auditive*," from its resemblance to the vitreous humour; as, however, Scarpa described this liquid correctly it might be named after him. Thus, then, the acoustic nerve being expanded upon the membranous labyrinth, is suspended between two fluids.

Breschet, and after him Dr. Roget, have described and depicted a white calcareous body in each of the vestibular sacs, which, according to the latter, "seems to be suspended in the fluid contained in the sacs, by the intermedium of a number of nervous filaments, proceeding from the acoustic nerves." The author has several times sought for these bodies in the human Ear, but hitherto unsuccessfully, except perhaps in one instance; and upon inquiry he cannot ascertain that any of his anatomical friends have seen them, though he is aware that they are now frequently alluded to. As they are so very generally met with in the lower animals, yet most probably not universally in mammalia, it is possible that something of the kind may exist even in the human subject, and it is certain that a whitish matter is often found upon the surface of the membrane; though these bodies cannot however be of that great importance in the economy of the organ, always influenced through an atmospheric medium, and furnished with such an elaboration of ap-

pendages, as they are in animals whose medium of audition either varies or is extremely dense, and whose appendages, if they exist at all, are merely rudimentary.

Section V.

The *Nerves* connected with the Ear require rather more than mere enumeration; inasmuch as the physiology of the nervous system, founded, as it always ought to be, upon its anatomy, is now engaging the particular attention of medical philosophers. As it happens in the formation of the nervous system, as of every structure of the animal body, that each atom is deposited from the arteries in its own proper place, it becomes incorrect to describe the nerves as arising or growing from any one part: these cords should rather be traced, as Serres, Solly, and others have done, in the direction they transmit, the impressions they receive; thus the auditory nerve should be considered as proceeding from the Ear backward to the brain, and the facial, on the contrary, from the brain outwards to the face. This matter is, however, of much less importance than many persons seem to imagine, it being now perfectly understood, that the nerves do not grow from their place of attachment like a vegetable from its roots: for the sake of convenience, the nerves of the Ear may therefore be traced in the ordinary manner from the brain, the dissection in that direction being more easily performed.

The *Acoustic Nerve* or *Auditory* (Plate X., fig. 2), is the eighth of the brain, though, until lately, from the time of Willis, it was reckoned as the soft division or portio mollis of the seventh pair, simply in consequence of the facial nerve passing through the foramen auditivum with it, though the attachment to the brain, the termination, structure, and function of each very widely differ. The Auditory Nerve has two attachments to the medulla oblongata: thus the anterior is affixed to the inner side of that prominence which forms the fourth ventricle, and has been named the Corpus Pyramidale Posterius; whence it passes outwards in front of the Corpus Restiforme, to unite

with the posterior division: this last proceeds from the lower part of the fourth ventricle by four or five white striæ, and winds behind the corpus restiforme, which is thus included in a groove between the two portions. The nerve thus formed, passes outwards and a little forwards through the foramen auditivum internum to the bottom of the meatus, accompanied and slightly grooved on its anterior and inner margin by the facial. It here divides into at least three sets of filaments; the superior pass through the upper foramina behind the opening of Fallopius' aqueduct, and are chiefly distributed to the ampulla of the superior semicircular canal, sending branches downwards to the vestibular sacs; the inferior generally pass through the bone in two divisions, — the larger and upper going into the vestibule, to supply its sacs and also the horizontal canal, particularly its ampulla, the smaller and lower reaching the ampulla of the posterior canal; the largest portion of the nerve passes through the base of the modiolus, which it traverses, and in its course sends numerous filaments through the pores to be expanded in a very regular manner upon both surfaces of the membrane of the scalæ: the terminal branch distributed to the infundibulum, being the largest. All the filaments are at first fibrous and strong, and afterwards become soft, acquiring somewhat the character of mucus. It is worthy of remark, that the ampullæ are much more abundantly supplied than the rest of the canals. The Auditory is a nerve of peculiar sense, being impressed only by one agent.

The *Facial Nerve*, *Seventh Cerebral*, or *Portio Dura*, (Plate X., fig. 2), is distinctly a motor nerve, distributing its bulk to the muscles of the face; yet as it has some connections with the Ear, it may be alluded to in this place. This nerve is usually described as arising from the groove between the corpus olivare and corpus pyramidale, immediately below the pons varolii, which, however, is merely its point of emergence; for it may be traced inwards, and found to be attached to the motor tract by two bands; one proceeding from that part within the pons varolii, runs outwards in front of the sentient division of the fifth; the other, commencing from the motor

portion of the corpus restiforme, passes behind the same division of the fifth, and unites with the preceding. The nerve thus formed, traverses the meatus internus, lying upon the internal and anterior margin of the auditory; it then enters the canal of Fallopius, through which it passes to the Parotid Gland. Along the posterior border of the facial, resting upon the auditory nerve, is a distinct band, proceeding from the groove of the medulla oblongata, and termed Portio Intermedia or Facialis Minor, the principal nerve being then called Portio Major; this portion is readily seen in the dead subject, and is well depicted by Arnold; in the meatus it sends two twigs to unite with the portio mollis, whilst the bulk of the nerve passes on to that gangliform enlargement of the portio dura, which is situated on its first posterior curve; from this enlargement two twigs pass backwards, to be also connected with the acoustic nerve. Swan has likewise noticed the connection between the facial and auditory nerves, but has not so minutely described it as Arnold: the former thinks that by this union the impression of sound may be communicated to the brain without the intervention of the Ear, through the medium of the facial ramifications. From the swelling of the facial nerve a minute twig runs forwards to the foramen ovale, and apparently reaches the otic ganglion. Near this point the nerve receives the *Vidian* or *Nervus Innominatus*, which is merely united by its sheath, and does not form with it a common nerve. The Facial in its course through the bone gives a good sized twig to the tensor tympani, part of which reaches the Eustachian tube; then a filament or two to the tympanic plexus; next a branch to the stapedius; and lastly, near the termination of the aqueduct, the vidian leaves it under the name of the *Chorda Tympani* (Plate X., fig. 2).

This interesting nerve, the *Vidian*, or, as Arnold terms it, the *Great Superficial Petrosal*, appears to be subservient to general communication; proceeding from Meckel's ganglion in common with a larger branch, which descends to the carotid plexus, its runs backwards into the cranium, through the pterygoid or vidian canal; then along the hiatus Fallopii to the aqueduct, which it leaves

to cross the tympanum between the long crus of the incus and manubrium of the malleus; it emerges at an opening in the fissura glasseri, and afterwards unites with the true gustatory, which it again leaves to communicate with the submaxillary ganglion. In this course it forms many communications, some of which are connected with the Ear: first, with the sympathetic in the carotid canal, than with the portio dura; thirdly, it gives branches to the tympanic plexus; fourthly, to the laxator tympani; fifthly, it receives a twig from the otic ganglion; sixthly, it joins the gustatory; and lastly, with the submaxillary ganglion, the branches from which supply the salivary glands in the vicinity. Although this account of the vidian nerve is generally considered as correct since the description of H. Cloquet, yet Cruveilhier denies its accuracy, asserting that the nerve not only comes in contact with the facial, but forms a part of it, and that the chorda tympani, being a distinct branch of the portio dura, forms a part of the gustatory.

The *Ganglion Oticum* or *Auriculare*, was discovered by Arnold of Heidelberg, and was supposed by him to have the same connection with the muscles of the tympanum as the lenticular ganglion is known to possess with the iris. It is a small, soft, reddish body, larger in proportion in the fœtus, situated immediately below the foramen ovale; it rests on the inner surface of the third division of the fifth, between it and the Eustachian tube, and immediately in front of the great meningeal artery; this concealed situation was doubtless the cause of its remaining so long undiscovered. This nodule possesses the communications of a sympathetic ganglion, and distributes its branches in a similar manner. There may be traced, 1st, twigs of union with the superior maxillary of the fifth; 2d, posterior branches, one uniting with the facial, another with the tympanic plexus, and particularly a large one to supply the tensor tympani; 3d, anterior branches to the soft palate and tensor palati; and 4th, descending branches long and slender, to communicate with the chorda tympani, and especially the pterygoid nerve, while one accompanies the spheno-spinal artery to the carotid plexus, by which it becomes indirectly con-

nected with the first cervical ganglion of the great sympathetic. This distribution will be better comprehended by a reference to the annexed copy of Arnold's plate (Plate X., fig. 1).

The *Tympanic Plexus* was described by Jacobson, and afterwards denied to exist; but it appears to have been demonstrated by Lobstein. The plexus is situated near the promontory of the tympanum, and is formed by the union of twigs from the sympathetic nerve, otic ganglion, chorda tympani; and some anatomists enumerate also from the portio dura, and glosso-pharyngeus; from the latter, by the nerve of Jacobson: the plexus supplies in particular the membrane of the tympanum, and the mucous membrane of the cavity and of the Eustachian tube, together with the other structures, as the muscles, &c. Arnold has also traced a branch from the *Par Vagum* into the tympanum, which appears to be distributed to the bones and muscles, and he thus ingeniously accounts for this peculiarity in the great nerve of respiration. In the very early periods of fœtal life, when in obedience to the general type of animal formation, rudimentary branchiæ or gills exist, the tympanum with its ossicles assists in forming these transient organs, and being of course at that time supplied by the par vagum, the twig still continues after the arrangement has disappeared.

The *Arteries of the Ear* are derived both from the External and Internal Carotid, but chiefly from the Basilar. From the external carotid are the *Posterior Aural*, supplying the auricle and meatus, and which gives off the *Stylo-mastoid;* this latter passes through the foramen so named, and divides into numerous small branches, supplying the mastoid cells and the labyrinth, one branch in particular uniting with the *Ramus Tympanicus* of the internal maxillary, forms a coronet around the membrana tympani, upon the surface of which many ramusculi are ramifying. The *Anterior Aural Arteries*, two or three twigs from the temporal, supply the forepart of the auricle and the meatus, and anastomose with the posterior. The *Tympanic Artery*, from the commencement of the internal maxillary, passes through the glasserian fissure,

forms the coronary vessel above noticed, and supplies the cavity of the tympanum. There also proceeds an *auricular* branch from the occipital. From the internal carotid a branch comes off in the carotid canal, which runs backwards and outwards to the tympanum to anastomose with the tympanic and stylo-mastoid. The largest artery is the *Internal Auditory*, which arises from the Basilar, and runs outwards and forwards, through the internal meatus, along the under margin of the portio mollis, supplying the nerve in its course: at the termination of the meatus it divides into many branches which accompany the nervous filaments into the labyrinth, the greater number pass to the axis of the cochlea, and thence to the scalæ.

The *Veins* accompany the arteries, with the exception already mentioned.

The *Lymphatics*, for the most part, accompany the veins in the ordinary manner, and pass to the nearest glands.

PLATE X.

Fig. 1. — *View of the Otic Ganglion.* — A. Left Side of the Cranium seen from within. B. Petrous portion. C. Ethmoid Plate. D. Turbinated bones. E. Carotid Artery. F. Internal Jugular Vein. a, Otic Ganglion sending its branches to the Tympanum, to the soft palate, and its descending twigs of communication; b, Meckel's Ganglion; c, Semilunar Ganglion; d, Ophthalmic nerve; e, Superior Maxillary; f, Inferior Maxillary; g, Chorda Tympani; h, Malleus; i, Incus.

Fig. 2. — *Acoustic and Facial Nerves.* — A. Section of the Petrous bone. B. Meningeal Artery. C. Semilunar Ganglion; a, Portia dura; b, Portio mollis; c, Portio intermedia, and its connections with the two former; d, Enlargement of the knee of the Portio dura receiving, e, The Nervous Innominatus, f, Chorda Tympani, g, Malleus, h, Incus, i, Tensor Tympani, k, Nervous filament from the Otic Ganglion.

Plate 10

Fig 1.

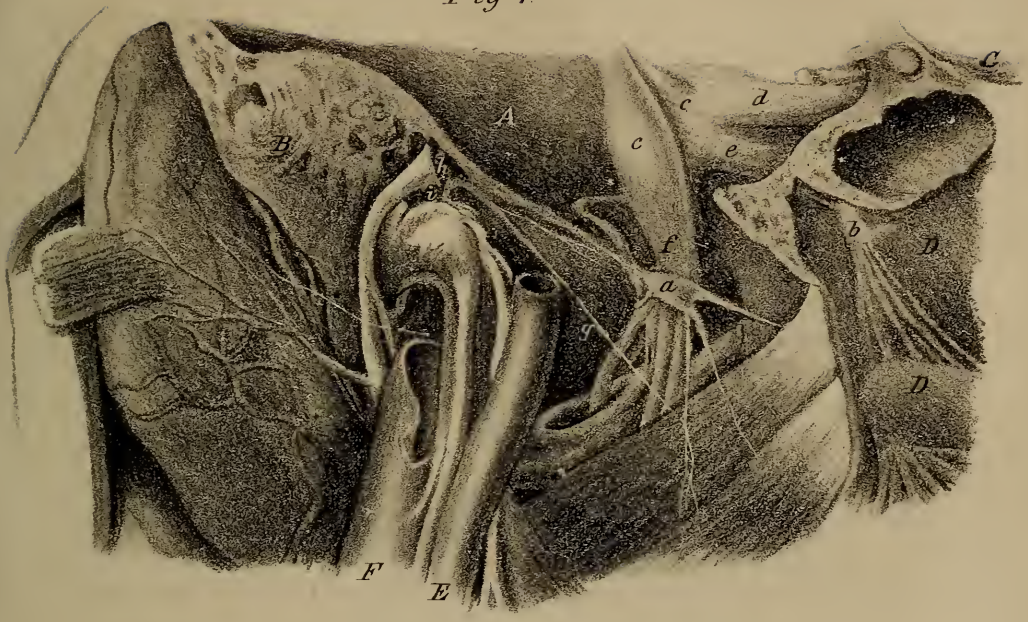


Fig 2.

CHAPTER III.

PHYSIOLOGY OF HEARING.

HAVING, in the description of the Ear, made slight allusion to the supposed uses of the various parts, it remains for us now to take a general survey of the physiology of hearing; through the medium of which function the mind is informed of the presence, movements, and many of the properties of bodies. It may be observed, that hearing and sight alone take cognizance of the relation and properties of distant objects, whereas we become acquainted with near bodies through the combined assistance of these and the other senses, particularly that of touch.

SECTION I.

As *Sound* is not matter, and has no positive existence, it has always been considered a difficulty to lay down an unexceptional definition of it. It may be stated, however, that sound is an effect upon the sensorium, produced by certain vibrations of the particles of a medium more or less elastic or movable, which effect is produced through an organ of hearing; the result occasioned by these vibrations through any other organ is rather to be attributed to feeling than hearing. The vibrations or oscillations of matter can and do occur without causing sound, in order to produce which, it is necessary that the animal organ should be so arranged as to receive the impression, and the brain so constituted as to perceive the effect. It would further appear, that the vibrations must be of a certain character, and of a certain rapidity, to produce the effect, as mere oscillation often excites no sensible impression. Every matter which possesses elasticity, or the particles of which are capable of moving upon each other, will propagate sound in degrees of intensity

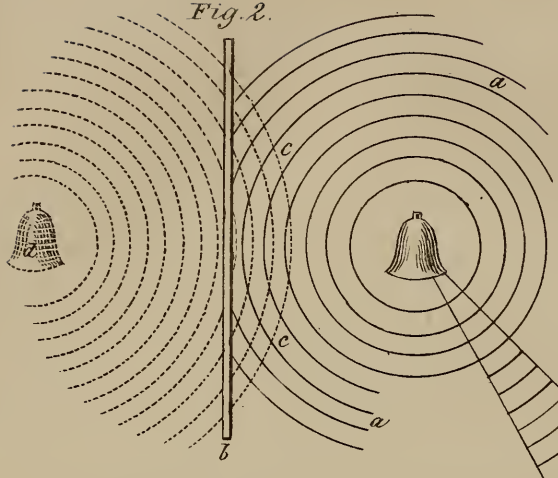
and rapidity, varying according to the density of the body, and its capability of motion; thus the earth, more dense than water or air, is not so good a conductor of sound, in consequence of its molecules possessing less mobility; on the other hand, it is an excellent reflector.

Sound is propagated through a *fluid* medium, by undulations or waves of the medium; the sound itself does not travel from the sonorous body to the ear, but the particles of atmosphere or water being displaced or urged onwards by the vibrating body, meet with a resistance from the next layer, and the particles flow back again, having in like manner influenced that layer, which acts upon a third and then recedes, and so on, undulation after undulation is formed, until becoming weaker and weaker they at last cease (Plate XI., fig. 1). The manner in which sound travels is not inaptly illustrated by the circular waves produced in still water by a stone falling perpendicularly into it, the waves being deep and powerful in proportion to their proximity to the stone, and to their small circumference, each circle increasing in extent and diminishing in power, until by the influence of friction and attraction they cease altogether; or by the regular and diminishing undulations of standing corn, in consequence of an impression made upon the extremity of the line by a blast of wind. The undulations produced by sound are unlike these similies in not being merely horizontal, as they likewise form perpendicular circles, altogether taking a globular form, as far as the surrounding resisting bodies will admit. It is evident that an imaginary section of such spherical waves, proceeding from the centre to the circumference, will form a cone, with its apex at the sonorous body, and its base at the termination of the sound; this cone, for the sake of convenience of description, is imagined to be made up of numerous rays, a ray being the smallest division into which the cone can be separated (Plate XI., figs. 2, 3).

The *laws* by which the sonorous rays are regulated, are similar to those of light; thus, each ray passes in a straight direction through the same medium; and separating from those originally in its immediate contact, they all diverge in arithmetical proportion, according to the square of its

Plate 11.

Fig. 2.



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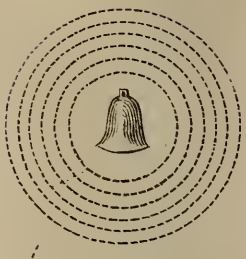

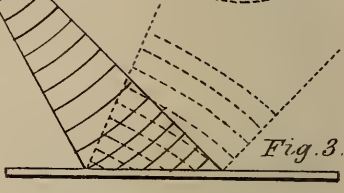

Fig. 3.

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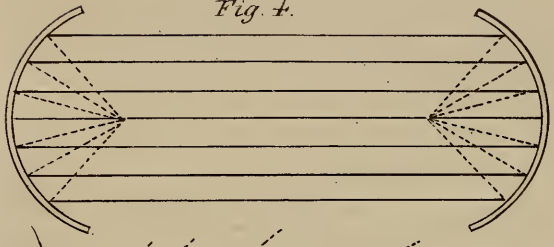

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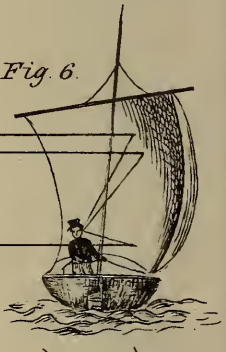

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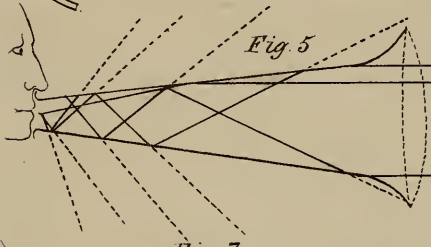

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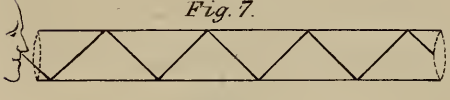

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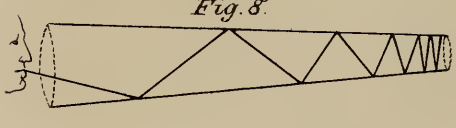

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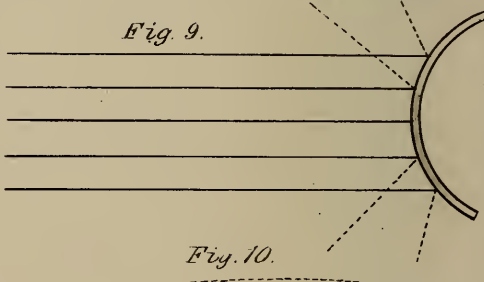

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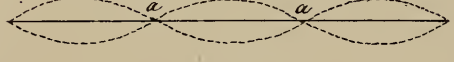

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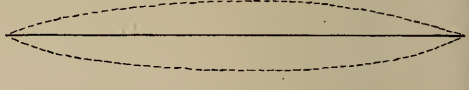

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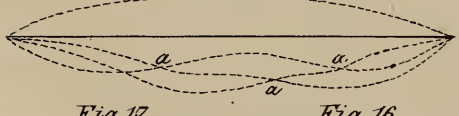

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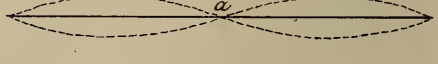

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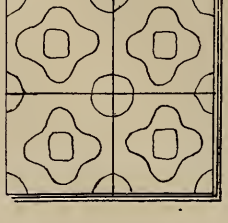
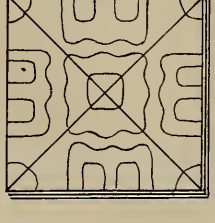


Fig. 16.



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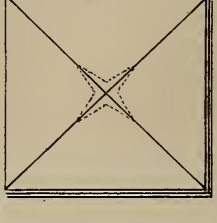

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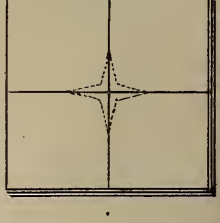

root; that is, at the distance of two measures it will occupy four times the extent, — at three nine times, — at four sixteen times, and so forth; the sound thus occupy-

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PLATE XI.

Fig. 1. — Shows the Radiation of Sound, diverging in arithmetical proportion.

Fig. 2. — Sonorous Waves, a a. striking upon an obstacle, b. are reflected in the same direction, c c. as though they proceeded from a point, d. at similar distance on the opposite side of the reflector.

Fig. 3. — A Section of the same Circle of Waves, forming a cone, and more clearly proving the angles of incidence and reflection to be the same.

Fig. 4. — Represents the Reflection of Sound from two opposite concave surfaces, by which it is converged to a focal point.

Fig. 5. — The influence of the Speaking Trumpet in condensing Sound, by reflection from its walls, in consequence of which the waves escape parallel from its extremity.

Fig. 6. — The same Waves, falling upon the expanded sail of a distant vessel, are reflected to a focus, and distinctly heard.

Fig. 7. — The Reflection of Sound in its transmission through a cylindrical tube.

Fig. 8. — The same through a conical tube.

Fig. 9. — The Divergence of Sound produced by its reflection from a convex body.

Figs. 10, 11, 12, 13. — Musical Strings in vibration: the straight lines are the strings at rest — 10 would give the Fundamental note — 11 the first — and 12 the second Harmonics. — 13. Shows the real Motion when compounded of the other three. — a a a. Are the Nodal Points where the strings are at rest. (See *Somerville on the Connection of the Physical Sciences.*)

Figs. 14, 15, 16, 17, are four of Chladni's Figures, showing the Arrangement of Sound, occasioned by the different Modes of Vibration of a Plate of Glass, &c., corresponding to Musical Notes of various degrees of pitch.

ing a greater and greater space, becomes proportionately diminished in intensity, until at last it is imperceptible. Thus being acquainted with the amount of sound at a given place, by calculating its diminution when it has reached his ear, the engineer is enabled to form a tolerably correct estimate of the distance between him and the spot from whence the sound issues. Of these scattered rays, which form the base of a large cone, but few fall upon the Ear.

Many simple experiments are daily performed to elucidate the fact above stated, that matter, elastic or freely moving, only can propagate sound; thus, a sonorous body evidently in action in a vacuum, even the partial one produced by mechanical agency, as a bell in the exhausted receiver of an air pump, does not produce sound, there being no, or rather too few, particles of air to undulate sufficiently to influence the Ear; and in proportion as the air is readmitted, the ringing at first faint becomes louder and louder, and if the air be condensed, it becomes more distinct than under ordinary circumstances. This fact again may teach the philosopher to what height he has ascended above the earth's surface, for in exact proportion as the atmosphere becomes rarified, sound becomes less distinctly conveyed. "Saussure reports that a pistol fired on the summit of Mont Blanc, produced no greater report than a little Indian cracker would have done in a room." There is an admirable correspondence between the rarefaction of the atmosphere in elevated positions, and the organs of the animated beings which inhabit them. On the contrary, when the air is more than usually dense, and particularly if it be, as it generally is, at the same time calm, sound will be more distinctly conveyed.

The surrounding medium being of course the conductor of sound to the animals which inhabit it, and as these media vary in this property, by making a very few observations upon these differences, we shall be led to admire the consequent all-wise modification of the acoustic organ.

The *Atmosphere* in virtue of the great elasticity, and the extreme mobility of its particles, is a conductor of sound, admirably adapted to the delicate and well developed

ears of mammalia; its molecules are easily compressed and displaced, and having influenced the globules immediately in contact with them, they as readily recover their natural condition and situation. As the elasticity of the air is definite under ordinary circumstances, so likewise is its capability of transmitting the sonorous rays; which capability depending, as we have seen, upon the density and equilibrium of the medium, will vary as regards the clearness and distinctness of the sound, though not as regards the rapidity of its passage, which will be considerably less than in denser matters, as water, and most solid bodies.

According to Halley and others, sound travels through our atmosphere at the rate of 1142 feet per second, which is ten times faster than the most violent hurricane; but the Dutch who experimented most accurately in 1823, make sound to travel 1089·42 feet per second, which nearly agrees with the estimate of the French. The mean 1090 feet, according to Sir John Herschel, or 363 yards, is within a little of the truth; the velocity is increased 1·14 feet for every additional degree of temperature. In England sound travels about 9000 feet in eight seconds, 12¾ miles in a minute, 765 an hour, about three-fourths of the diurnal velocity of the earth's equator.

It was found that the velocity of sound, determined by observation, exceeded what it ought to have been theoretically, by 173 feet, or about a sixth of the whole amount, which La Place suggested might arise from the increased elasticity of the air, in consequence of a development of latent heat during the undulations of sound, and calculation confirmed the accuracy of his views.

The *distance* to which sound will be conveyed, depends upon a variety of opposing or favouring circumstances; as a number of undulations passing in various directions producing confusion in the hearer, — the state of the atmosphere, — the mechanical opposition of solid bodies,— and particularly an acute sense, will appreciate sound at a distance quite imperceptible by one of ordinary sensibility, and it is known that certain animals are capable of hearing at a much greater distance than man. In consequence doubtless of the diminished elasticity of the air,

it happens that fogs, rain and snow, obstruct the progress of sound; whereas the surface of quiet water, and ice, increase its clearness and strength. This effect, it may be presumed, is produced by two causes, partly by the reflection from the surface of the water or the ice, and secondly by the vibration of their particles, the latter effect might be expected to be more perfect in the fluid, whereas the reflection would be more complete from the surface of the solid water. It is well known that by the side of a canal sound may be heard at an astonishing distance; thus, Dr. Hutton heard distinctly a person read on the Thames near Chelsea, 140 feet distance, whilst he could hear the same voice on land only seventy-six feet; Lieut. Foster in the Polar expedition, held a conversation with a man a mile and a quarter distant, across the harbour of Port Bowen when frozen; Dr. Young says, at Gibraltar the human voice was heard ten miles off.

According to Derham, guns fired at Carlscroon were heard at Denmark, eighty or perhaps 120 miles distant. Dr. Hearn heard guns fired at Stockholm, 180 miles off. The cannonade of a sea-fight between the English and Dutch in 1672, was heard across England, at Shrewsbury and Wales, upwards of 200 miles from the scene of action. This last is a very remarkable circumstance, and it is to be remembered that in all to which allusion has been made, the sound travelled for the greatest part of the distance along the surface of water. The fact that sounds are more distinct and clear, and can be heard at a greater distance by night than by day, appears to be due, not only to the greater stillness then existing, and to the sense being engaged with one sound instead of many, but as Humboldt has said, to the greater homogeneity of the atmosphere, its density not then being affected by the partial variations in temperature.

In consequence of sound requiring a definite time to reach the Ear, and light passing to our senses instantaneously, — which 192,500 miles in a second may be considered to be, — we are enabled to judge of the distance of a body at the same time luminous and sonorous; thus, we learn the distance of the thunder-cloud, by computing the time required for the sound to reach the Ear

after the lightning has been seen; thus, the artilleryman ascertains tolerably exactly the distance of the enemy, he sees the flash and afterwards hears the report of the gun, and reckons accordingly. The mechanic, aware that sound travels faster than a solid body descends, having let a brick unintentionally fall from his lofty scaffold, calls lustily to passers by to escape the danger, while it is yet descending.

Under the common circumstances of nature, water has been considered inelastic or incompressible, and though Sir H. Davy proved the fallacy of that dogma, the extreme amount of pressure required to produce even a slight condensation, is such as to justify the above general conclusion under ordinary occurrences; therefore, it is hardly to be expected that in transmitting sound, its molecules suffer the least compression; but that freely moving against each other, one layer will more completely displace the next, its recession will be more rapid, and thus the sonorous undulations will not only travel faster, but also make a much greater impression than those of the elastic atmosphere. The fact has long been known, the a noise which was moderate in the air, has been quite stunning under water; from the experiments of M. Colladon, made at the lake of Geneva, which seems to be admirably adapted for the purpose, it appears that under water sound travels 4708 feet per second, upwards of four times faster than in air; and the increased strength is perhaps in the same ratio. The first Monro performed some interesting experiments in a lake near Edinburgh, and proved the same general results, though he did not arrive at M. Colladon's accuracy. We have noticed above the circumstance of sound being conveyed more clearly along the surface of water, in which instance it is most probable that the sonorous rays are increased in number, by reflection from the water's surface into the atmosphere; but that the particles of the water also are affected, and assist in conveying the sound, seems proved by the fact, that under the influence of favouring conditions, two sounds reach the Ear with different rapidity, one conveyed by the water, the second by the air.

The most obtuse comprehension must be struck with the design of the Supreme Artificer, in rendering the circumambient fluid the means of conveying sound, and in adapting the organs, of the denizens of this fluid to its greater or less capability of performing this all important office; what would be the result, if the inhabitant of the atmosphere possessed the ear of the fish? The slighter influence of sound would produce too little effect upon the vestibule and semicircular canals through the skull, to sufficiently influence the acoustic nerve, and hearing would be very partially if at all excited; whereas if sonorous waves were communicated to the ear of a mammalian, and particularly of man, through the medium of water, so stunning an effect would be produced, as to be incompatible with the due discrimination of sounds, and the healthy condition of the organ.

Solids are also excellent conductors of sound, for resisting as they appear to be, vibratory motions take place in their particles, when under the influence of a sounding body: and in virtue of the density of the solid, the power of conduction will be greater even than in the fluid: thus, it is well known that the Ear placed in contact with one extremity of a long log of wood, will most clearly receive the impression produced at the other, by a slight stratch of a pin. The velocity is likewise very great; thus, for example, a blow struck at one extremity, will be distinctly heard at the other; first, by the Ear placed in contact with the wood, and soon afterwards by the other Ear, through the medium of the atmosphere; and the same simple experiment may be performed by the aid of a brick-wall. An iron wire, several hundred feet in length, will afford a still more accurate example, for being a very dense body, its vibrations are smaller and more rapidly conveyed. It is calculated that sound passes through iron, and some wood, at the rate of 18,530 feet in a second. It is also found that sound is more clearly conducted in the immediate vicinity of a straight wall, chiefly, no doubt, because the rays are not only prevented from diverging in that direction, but also, because being reflected from the hard surface, a greater

number must reach the Ear; and it is also more than probable, that the vibrations of the wall itself may assist in producing this increased effect.

Sound, however, is modified, by being conducted through different media; thus, when excited in the atmosphere, it is but indistinctly heard by the diver under water; and the angler may see the agitation of the water excited by the fish, but will not hear the noise produced, unless the animal be near the surface; thus again a wall will suffer but slight vibrations in consequence of the atmospheric sonorous rays, and we consequently hear the music of our streets but partially in our closed apartments, in which case the diminution of hearing will be in proportion to the thickness of the walls, and the perfection of the windows.

In describing the physiology of hearing, it is necessary, in order to be quite explicit, to allude to a most important law, to which sound is subject in a manner very similar to *light;* there is a near resemblance in the laws which regulate the sonorous vibrations and the matter of light; if, indeed, light be matter, and if it be merely the vibrations of an ether, the same observations will still apply. They travel in the same direction, form the same spheres and cones, diverge in the same proportion, but proceed with infinitely different rapidity. But the law of *Reflection*, to which both light and sound are subjected, and precisely in a like manner, requires the especial attention of the physiologist, as the eye and the ear of the higher animals are adapted to produce these reflections, without which the function of neither organ would be accurately accomplished. It has been already seen that, in order to be a perfect conductor, a solid body must be the immediate recipient of sound from the sonorous producer, and not indirectly through a rarer medium; thus, the rays travelling through the atmosphere, and striking upon a resisting solid, will doubtless produce a slight effect upon it, which effect will be regulated by the amount of resistance, but rarely sufficient to excite sound; the atmospheric undulations will recede from the resistance, and the sound will travel back again exactly in the same manner as it originally proceeded from the produc-

ing power, of course weakened in proportion to the distance it has extended, and in consequence of its force being partly broken upon the surface (Plate XI., figs. 2, 3). This *reflection* of sounds, is termed *Catacoustics*, in contradistinction to *Diacoustics*, which relate to sounds directly striking the Ear; as in light so in sound, the angle of incidence and of reflection, are always equal; and by this simple geometrical law, the various phenomena may be accounted for; the single ray only which falls in a straight direction upon the surface, will be reflected back to the spot from which it proceeded; as every other ray of the cone must be more or less oblique in proportion to its proximity or distance from the centre, so will it be reflected with exactly a similar obliquity, and in precisely the opposite direction. It becomes therefore very evident, as each particle of a solid is really flat, and the ray or rays falling upon it will form with it their peculiar angle, that the general shape of the surface will vary the general reflection; that projecting surfaces may be so arranged as to produce repetitions of reflections; and that in a tube the rays will be thrown from one surface to the other again and again to their exit. A few examples will suffice for elucidation; if sound falls upon a flat wall, it is reflected, but too few of the rays reach the Ear to produce an effect, or a noise only may be appreciated; but if the wall should be angular, the sonorous rays reflected from each surface may meet and be so much increased in power, as to occasion an *echo*, which is a weakened repetition of the first sound: if the angular surfaces be several, and so situated as to receive the reflected sound from each other, several echos will arise, each becoming fainter than the preceding. There are many interesting examples of such repeated echos; the Author counted nine, from the rocks at Lurlei Folsen on the Rhine, occasioned by the report of a pistol; Herschel describes the remarkable reflections under the Menai-bridge; those at the lakes of Killarney are well known: — in Woodstock-park an echo repeats syllables fifteen times by day, and twenty times by night. If the reflecting surface be concave, the rays will be directed from every part towards a focus; if, on the contrary, it be convex,

they will be still further diverged (Plate XI., figs. 4, 6, 9): thus an echo is sure to occur from the walls of a circular apartment; and if it have also a dome, a focus will be formed somewhere near the centre, rendering the building exceedingly inconvenient for the purposes of speaking, as is frequently witnessed in the theatres of the Medical Schools. As a circle is an union of numerous small planes, so will the sound be reflected from plane to plane, completely round the building, and an Ear placed against one part of it, will distinctly receive the impression produced by a mere whisper in another, constituting one form of the whispering gallery. In a perfect whispering gallery, many rays, reflected from various surfaces, meet in one point or focus, and give rise to a strength of sound, which seems almost incompatible with the original. The alcoves on Westminster-bridge afford an instance of this kind; a whisper at the focal point of one alcove, which is near the centre of the parabola, supposing it to be complete, will be readily heard at the focus of the opposite alcove, across the bridge, the sound having then undergone two reflections. "In the cathedral at Girgenti, in Sicily, the slightest whisper is borne with perfect distincness from the great western door to the cornice behind the high altar, a distance of 250 feet. By a most unlucky coincidence, the precise focus of divergence at the former station, was chosen for the place of the confessional. Secrets never intended for the public ear thus became known, to the dismay of the confessors, and the scandal of the people, by the resort of the curious to the opposite point, (which seems to have been discovered accidentally,) till at length, one listener having had his curiosity somewhat over-gratified, by hearing his wife's avowal of her own infidelity, this tell-tale peculiarity became generally known, and the confessional was removed." The Navigator, hailed from a ship, far too distant for ordinary intercourse, places himself in the sonorous focus of his expanded sail, and holds ready communication with his interrogator similarly situated, though at a distance of several miles (Plate XI., figs. 5, 6). These examples might be indefinitely multiplied; but sufficient has been stated, for the mere purpose of

elucidating the influences of the animal organ upon sound. Allusion may, however, be made to the vast importance of attention to the laws of acoustics, on the part of the architect, in erecting a building for public speaking, or for music; very few of such erections are well adapted to the purposes intended. In the beautiful church of St. Sepulchre, the audience would lose half the sentences of the Preacher, were it not for the large concave reflector placed immediately behind the pulpit, which, although of great general utility, occasionally produces an almost ludicrous variation in the tone as the speaker changes his position.(*a*)

(*a*) The *reflection* of sound is well described in the following paragraph of *Müller's Physiology*, (American Edition, 1843), p. 750: —

"In relation to their reflection, the undulations of sound resemble those of light; in passing from one medium into another different one, they are in part reflected, and in part only propagated onwards. The ticking of a watch placed in the focus of a concave mirror may be heard in the focus of another mirror placed so as to receive and concentrate the reflected sonorous undulations. It is owing to sonorous vibrations of air being propagated with more facility in that medium than they are imparted from it to solid bodies, that sounds are transmitted in their full intensity through tubes, just as on the same principle solid rods propagate sonorous vibrations to great distances almost without any loss of intensity. A *speaking-trumpet* represents a parabola, in the focus of which the sound is excited. Being reflected by the parabolic surface, the sonorous undulations are all thrown in a direction parallel to the axis of the parabola. The cause of the increased intensity given to the sound by the *speaking-trumpet* is, for the most part, the coincidence of newly excited undulations with others already reflected, producing undulations with greater condensations and rarefactions. But the resonance of the confined mass of air in the tube also contributes to this effect; for the air of a tube open at both extremities, while it propagates sound, also becomes the seat of resonance. The *ear-trumpet* becomes narrower towards the ear, and consequently concentrates the sonorous undulations. If its walls have the parabolic form, and the focus of the parabola be at a point near the ear, sonorous undulations coming in a direction parallel with the axis of the parabola will of course be brought to a focus near the ear. (*Eisenlohr*, loc. cit., p. 164.) If a reflecting surface is situated so as to throw sonorous undulations upon the ear, and is at

The animal physiologist would rather dwell upon the reflection of sound through tubes; for though every person may not agree with the author that such an effect occurs in the meatus auditorius, yet no one doubts the necessity of a tube varying in length and dimensions to produce the almost infinite modulations of *voice.* The reflection of sound occurs from the sides of a tube, in a manner similar to that from a concave surface, the angle of incidence and that of reflection being equal; the interior being a circle, the rays are thrown from every part to the opposite surface, and thus the reflections are multiplied in proportion to the length and dimensions of the tube: hence the longer the instrument the more numerous will be the reflections, and the deeper and fuller the note. All the holes of the flute being closed it becomes a long tube, and the low note is sounded; the first finger being raised the tube is shortened, the air rushes out of the opening, and a high note is the consequence. The human windpipe affords an excellent example of the same instrument, the deep tones are only to be produced by lengthening the tube from the lower end of the trachea to the lips, which are also protruded, the larynx being likewise expanded; and to give a high note the singer throws back his head, retracts his lips, shortens his pharnyx, diminishes the rima glottidis, and lessens the trachea. Without doubt the variation in the diameter of the vocal apparatus will have the chief influence, but the trachea and pharynx importantly assist in the operation by varying their length.

The shape of the tube must have an important influence; if it be of the same size throughout, the sound will be simply condensed and strengthened by the reflections; if it be tapering like a flute, the angles will become more and more acute, and the note deeper, the sound being in-

such a distance that the reflected undulations reach the ear perceptibly later than the undulations coming direct from the sounding body, an echo results, which is perfect when the difference of time is so great that the two series of undulations strike the ear at perfectly distinct periods."

creased; if on the contrary it be conical, the apex receiving the sound and the base giving it exit, as in a speaking trumpet, the angles will be less and less acute, till the last may be even obtuse: thus the exact dimensions of each section of such instruments becomes a matter of vast importance (Plate XI., figs, 5, 7, 8).

Tubes of wood, metal, glass, &c., are not merely conductors of sound by preventing the rays from diverging, and increasing their power by reflection, but the molecules of the instrument themselves vibrate, and that in harmony with the sound introduced, becoming thus indeed musical, though varying in their perfection. The musical sound is, however, rather to be attributed to the influence produced upon the column of air contained in the tube, than to the reflection of the rays thrown into it, and the vibration of the instrument. It becomes very evident, therefore, that tubes by preventing sound from being lost in the air by expansion, must conduct it to an almost indefinite distance; hence, the great utility of speaking-pipes to convey the slightest sound from one apartment to another. M. Biot, at one end of the iron conduit, 3120 feet long, laid down to supply Paris with water, distinctly heard the lowest whisper made at the other; he was then also afforded an additional proof that notes of different pitch pass with equal rapidity. Water poured from a jug into Carisbrook well, in the Isle of Wight, which is 210 feet deep and twelve in diameter, and having the interior lined with smooth masonry, produces a report almost approaching to thunder.

A few observations may suffice with respect to the *causes producing sound;* whatever thus operates must do so by throwing the medium into a vibratory motion, and this is effected in various modes: for instance, by suddenly displacing a portion of the fluid, as of the air, by clapping the hands, or of the clouds by the escape of electricity in thunder storms; in these instances the matters displacing the air are also vibrating, by which, the effect will be increased.

The most usual and interesting cause of sound is the vibration of solid bodies, communicating to the conduct-

ing medium the same number and character of undulations. From what has preceded it will be understood, that the denser the solid the more perfect will be its vibrations, and the more perfectly will they influence the conducting medium; and as the atmosphere is the medium with which we are most conversant, the future remarks will have reference to that alone. The more completely the solid is condensed, or the smaller the space it occupies, provided the quantity is not lessened, its motions will be the more rapid; but in order to produce the most perfect effect a very dense body of small size, as a metal wire, should be stretched between two points. It is apparent that the more tensely this cord is drawn, the more dense becomes the material, and smaller in size, and in the same degree will be diminished its capability of vibrating through an extensive space; consequently just in an equal proportion will be its increased number of vibrations, and the limitation of each; in this manner is produced the acute sound, or the high note. Again, the thicker and longer wire of less dense material, and less tightly drawn, will vibrate slowly and through a more extensive space, producing less effect, and thus the grave sound or low note is occasioned. It is generally understood that the more tense the wire the more rapid are the vibrations, and that the metal may be tightened even to rupture, producing still the same effect; it is, however, very probable that the wire may be so arranged as to vibrate so rapidly, and through so small an extent, that it shall produce a note too high to be appreciated by the human Ear, a theory which Professor Wheatstone has applied to the membrana tympani. The wires and strings of musical instruments differ in density, in size, in length, and in tenseness; and the perfection of arrangement would be to vary the same wire in the above particulars so rapidly, that it might give rise to a great variety of notes; this is attempted to a certain degree as regards the length and the tenseness, and with considerable effect, but as that is insufficient, numerous strings or wires differing from each other are used. The *human larynx*, though probably chiefly a wind instrument, affords the best example of what a stringed instrument should

be to accomplish a great variety of tones, but art cannot imitate such perfection.

Probably no wire, however short and tense, nor an instrument of any kind, produces one single set of oscillations, that is, that it at once vibrates throughout its entire extent; but, as is most evident in strings of moderate length, one section is vibrating while another of very small extent termed the Nodal point, is at rest; the sections above and below which, are moving in opposite directions, and thus oscillating waves run along the wire in both directions from the point touched, the whole length of the string truly performs its vibration, but each section has besides its independent motion; these combined motions run up and down the string, producing *interferences* with each other, which assist, with the friction of the air and the specific gravity of the material, to reduce it to a state of rest (Plate XI., figs. 10, 11, 12,13). The harmony of the sound is importantly connected with the number and rapidity of the oscillating sections, of the nodal points, and of the interferences, and most interesting disquisitions are given of them in the various treatises on the science of music, to which it would be incompatible with the object of this essay further to allude.(*a*)

(*a*) Under the head of *undulations of inflexion or flexion-waves in solid bodies*, we read in Müller (*op. cit.*, p. 746): —

"If a stretched cord or string of a musical instrument is struck, not at its middle, but near one extremity, an extension of it is produced at this part, and is communicated as a wave or oscillation to the whole cord, travelling from one end to the other where it is reflected back again like the undulations of fluids.

"If the cord or string is struck several times in succession, a regular series of undulations is produced, as upon the surface of water. The reflection of these undulations at the extremity of the cord, and the meeting of the incident and reflected undulations, give rise to the stationary vibrations; and the parts of the cord which remain at rest between these stationary waves or vibrations are the 'nodal points.'

"The simplest stationary vibration of a cord or string is, however, that which results, not from the meeting of progressive undulations, but from the transverse vibration or movement from side to side of the whole cord between its fixed extremities, which here constitute the nodal points. This kind of vibra-

It is not at all requisite that the body vibrating so accurately as to constitute a musical instrument, should take the lengthened form, every shape will answer the purpose, provided it does not too nearly approach that of the cube, but the shape will modify the oscillations and consequently the notes produced, which are further influenced by the peculiarity of the matter used, and thus very different sounds may proceed in harmony from a great variety of instruments.

The vibrating material may be a plate of glass, of metal, or a sheet of parchment; the latter being stretched over an oscillating cylinder constitutes the drum in its different forms. These bodies also vibrate partially, having their nodal points or lines which are at rest. M. Savart, by many experiments, has proved that the vibrating portions of a plate of glass will form

tion is induced most readily by striking a string with the finger, or with a violin-bow. The transverse oscillation of solid bodies which do not owe their elasticity to tension, such as metal rods fixed at one extremity only, is also an instance of stationary vibration.

"Stationary undulations or vibrations are produced also when, by touching lightly a stretched string, we give rise to a nodal point in that situation, and then strike the part of the string thus isolated. If, for example, the string is touched at its middle, and either its upper or lower half then struck with the violin-bow, not merely does the half that is struck become the seat of transverse vibrations, but the other half also vibrates from side to side, though in the opposite direction. The number of the vibrations in a given time is in this case twice as great as when the string vibrates in its whole length, and the sound produced is the octave of the fundamental note of the string. If the string is touched at the point of junction of its first and middle third, a nodal point is formed between its middle and last third also, and the number of the vibrations is three times as great as that of the vibrations of the entire string within the same period. In the same way, by isolating and striking a fourth or fifth of the string, a regular division of the string into four or five vibrating portions, separated by nodal points, is induced. Pieces of paper placed upon these nodal points during the vibration of the string are not thrown off. The sounds resulting from the vibration of a string thus divided by nodal points are called 'harmonic notes.'"

triangles, squares, circles, semicircles, and indeed assume a great variety of shapes and forms, the neighbouring portions being of corresponding forms and at rest (Plate XI., figs. 14, 15, 16, 17). That this arrangement into portions at rest, and in vibration takes place, may be variously proved, as by running the wetted finger in different directions along the surface of the glass, or metal, or drum-head,— by carrying a bow across the margin,— by striking the surface in certain points and with a certain degree of force, in which cases the light particles of sand which have been previously scattered upon the plate or parchment, will arrange themselves upon the lines at rest in exactly corresponding forms. This circumstance is most usefully applied by engineers, who, when they anticipate, in the progress of a siege, the working of a mine beneath, although the noiseless caution of the enemy prevents any sound reaching the Ear, even when placed in contact with the ground, are able to discover the proximity and direction of the works below, by the mode in which the grains of fine gunpowder oscillate and arrange themselves, when scattered upon the face of a well-tuned drum, which has been placed in a position favourable to be influenced by the slight vibrations of the solid earth. Is it not possible that such partial vibrations, with their nodal lines, occur in the Membrana Tympani, assisting in the production of the infinite variety of sound known to take place?

Another excitant of sound, of great interest to the animal physiologist, is a narrow *aperture*, through which air is propelled with varying force, occasioning various notes, as the whistling of the air through the key-hole; although in this instance the chief cause is the force of the current through a mere aperture, yet it is more than probable that the slight vibrations of the lips of the opening will also modify the effect. The perfection of such an instrument will be in proportion to the degree of variation in the size of the aperture, of the resistance and elasticity of its lips, and consequently of their vibratibility, to the varying force with which the air is propelled through the opening; and if to these advantages be superadded an elastic and vibrating tube, changing its length

and diameter according to the note to be produced, a musical apparatus of almost infinite variation will be the result. As examples may be mentioned the clarionet, flageolet, pipe, and flute with the appendage of the vibrating lips of the performer. In the organ and Pandean pipes the want of variation in the tube is supplied by many pipes differing in length and size, with similarly arranged apertures, the air being thrown alternately into one or the other, occasioning the harmony required. Of all examples, however, the animal apparatus, and particularly that of the human being, is alone perfect; and when directed by a highly educated intellect, can produce every sound in nature, within the capacity of its strength, and very many which are not by other means to be formed. The uncivilized man's power of varying sound is comparatively very limited, though far exceeding that possessed by other animals, or that can be produced by other means, natural or artificial. Thus it happens that the invention of speech is perfected in proportion to the civilization of the community; the air is readily vocalized in its passage through the trachea, and particularly the larynx, but its further all-important modification in its transmission through the fauces, mouth, and lips, to constitute speech, requires a certain degree of advancement in intelligence and tuition.

Kratzenstein, and Kempelen, and later, Mr. Willis of Cambridge, have endeavoured to imitate the human voice, by adapting cylindrical tubes to a reed, the length of which can be varied at pleasure, by sliding joints: and to a certain extent they have succeeded, being enabled to pronounce by these contrivances the vowels at a different pitch, by drawing out the tube, whilst air was forced into it from the bellows of an organ. It is an interesting fact, that "when the pitch of the reed is very high, it is impossible to sound some of the vowels, which is in perfect correspondence with the human voice, female singers being unable to pronounce *u* and *o* in their high notes."

The vibrations must be of a certain duration to give rise to sound, and according to the very beautiful experiments of M. Savart, to which further allusion would be

misplaced on this occasion, it appears that *sixteen* single vibrations in a second occasion the lowest sound that can be heard; before these experiments were performed, it was supposed that twenty-four were required. The same philosopher has proved that the human ear can appreciate a sound occupying the *twenty-four-thousandth* part of a second; *i. e.*, that twenty-four thousand vibrations of a musical chord in a second of time, will produce the highest note which can be recognized. It was also formerly stated that 8,000 or 20,000 vibrations in a second formed the highest note that could be heard; of course it follows that the intermediate number of vibrations will be more distinct. From a variety of experiments, Dr. Wollaston concluded that human hearing is limited to nine octaves, extending from the lowest note of the organ to the highest known cry of insects; he adds, that "as there is nothing in the nature of the atmosphere to prevent the existence of vibrations, incomparably more frequent than any of which we are conscious, we may imagine that animals, like the Grylli, whose powers appear to commence nearly where ours terminate, may have the faculty of hearing still sharper sounds which we do not know to exist, and that there may be other insects hearing nothing in common with us, but endowed with a power of exciting, and a sense which perceives, vibrations of the same nature, indeed, as those which constitute our ordinary sounds, but so remote, that the animals who perceive them may be said to possess another sense, agreeing with our own solely in the medium by which it is excited."

It would be misplaced here to allude to musical sounds, — to that beautiful harmony, at one time exhilarating and at another soothing to the human mind, the capability of appreciating which, it would appear, was a mean designed by an all beneficent Providence, to augment the happiness of mankind, to allay feelings perturbed and prejudicial, and to encourage that calmness and resignation requisite to their peace both here and hereafter. We may, however, be permitted to conclude these remarks with one or two further observations upon the variety of sounds.

The *loudness* of sound depends upon the extent of vi-

bration, and not upon its rapidity, thus the high or low note may be loud or otherwise.(*a*) The difference of acute and grave sounds constitutes the *pitch*, which is a most important property in language whether in talking or in singing. "By the association of different *notes*, we have all the results of melody and harmony in musical sound; and of intonation and modulation of the voice, of accent, cadence, emphasis, expression, passion, in speech. The song of birds, which is one of their principal modes of communication, depends chiefly for its distinctions and its significance upon the combinations of the acute and grave." From the different relations of the number of vibrations in a second arise all the differences of musical intervals, concords, and discords. The term *quality* of sounds is given to notes of the same pitch produced by different instruments; thus, if a stringed and a wind instrument be in unison, and the same note sounded, the difference is still striking. This variety of quality, which is so very distinctive of different animals, and which distinguishes the voices of different persons, is evidently of much importance, as it connects the voice with the individual, and is indeed almost requisite, in order that language may become a medium of intercourse.

The *sympathy* of sounds arises from the vibrating bodies of different instruments being drawn up to the same pitch; thus the atmospheric undulations occasioned by the tone of a chord of the piano or Æolian lyre, will ex-

(*a*) "*Resonance*," says Müller (*op. cit.*, p. 749), "is a means of rendering a sound louder than it is as produced by the sounding body itself. It consists in increasing the extent of surface of a soniferous medium similar in kind to the sounding body. Hence the increase of sound produced by placing a vibrating tuning-fork upon a solid body. The influence of the bridge and sounding-board of stringed instruments is due to the same principle. Greater resonance is, however, produced by an insulated body than by one which has no circumscribed surfaces; for an insulated body reflects back a part of the undulations within it at its borders and surfaces, and, these reflected undulations meeting with the undulations newly excited in it, an increased extent of the excursions of the oscillating particles, answering to the increased height of the elevations of flexion-waves, is produced (*Weber*, p. 536)."

cite the vibration of a harmonious chord of a harp in a distant part of the room, having crossed the strings, out of concert with the originator of the sound, without in the least affecting them. The effect of this sympathy of sounds is extremely delightful when produced by several Æolian harps conveniently hung on the branches of trees, in a quiet evening, with occasional gentle breezes. May not the membrana tympani be drawn into harmonious sympathy with many sounds that strike upon its surface.

The quality of the human voice is dependent chiefly upon the capacity and elasticity of the larynx, and is modified into articulation during its further passage by the cavity of the mouth, and the surrounding organs. "The articulate character of sounds is for mankind one of the most important arrangements which exist in the world; for it is by this that sounds become the interpreters of thought, will, and feeling, the means by which a person can convey his wants, his instructions, his promises, his kindness, to others; by which one man can regulate the actions and influence the convictions and judgments of another. It is in virtue of the possibility of shaping air into words, that the imperceptible vibrations which a man produces in the atmosphere, become some of his most important actions, the foundations of the highest moral and social relations, and the condition and instrument of all the advancement and improvement of which he is susceptible."

This wonderful power of speech, the grand prerogative of mankind, could not have been invented without an Ear of the utmost delicacy to catch the infinite variety of sounds, and a Sensorium to perceive and reflect upon the impressions communicated through the organ. It is therefore all gratifying to trace the correspondence of development in the organs of speech and of hearing to their perfect condition in man, and whilst admiring, to adore the wisdom of the Divine Designer.

Section II.

INFLUENCE OF SOUND UPON THE EAR.

Of the sonorous rays that fall upon the auricle, some are, no doubt, reflected into the atmosphere; but with this exception, the sound striking upon the eminences is thrown into the cavities and grooves, and, increased in strength by reflection from the parieties, is conducted to the bottom of the concha, and probably this reflection particularly occurs from the inner surfaces of the tragus and antitragus. These prominences protect the meatus under ordinary conditions; and in the lower mammalia are raised to expose the opening for the reception of a greater quantity of sound; or are drawn more closely down for increased protection, as the will may be acting upon either the elevating or depressing muscles. Hence it follows, that the auricle is not merely the recipient of a larger quantity of sound, than would otherwise fall upon the meatus, but likewise that the rays are thereby condensed towards a focal point.

Though we cannot consider with Itard, that the external Ear is of no importance to the economy of hearing, nor with Buchanan, that the power of the function depends much upon its size and configuration; yet we cannot but consider it to be of considerable utility; the observations already made upon the outer ear of animals, as well as its greater development in the savage, where this part is unconfined by dress and habit, may direct us to comprehend the advantage it yields. The Author cannot but refer to the opinion of an intelligent friend, Mr. Swinburne, — that the auricle, at the same time that it will reflect some of the sonorous waves to the meatus, will in consequence of its structure prevent their reflection, and, as it were, absorb them, and thus diminish rather than increase their influence: to which opinion he was lead by the different effects produced, when the

auricle had accurately adapted to it plates of different metals and other materials.

The sound, thus influenced, passes along the meatus auditorius externus, and strikes upon the surface of the membrana tympani. In consequence of the animal temperature the rapidity must be increased, but so very slightly, as not to be ascertainable, and probably producing neither inconvenience nor advantage. As in any other tube the sonorous rays will be reflected from the surface of the canal, and consequently increased in power by condensation; and it is evident that the peculiar curved direction of the conduit will occasion the reflections to be such, that they shall fall with the greatest advantage upon the membrane, the obliquity of which structure admirably adapts it to receive them. Some further benefit than the mere yielding tendency of the outer portion of the canal is possibly derived from its being partly cartilaginous and partly osseous, in the greater degree of vibration possessed by the outer, and of reflection by the inner portion. Nor can we omit to allude to the diminution of the reflection, which otherwise might amount to an echo, that is caused by the cerumen.

The *Membrana Tympani* receives the sonorous rays prepared by the outer Ear, and exercises an important influence in propagating their effect to the sensorium. It is not a regular concavity, and hence probably does not possess a focus of reflection; its reflecting power is also limited by its fibrous irregularity; and it is therefore well adapted for vibration. Stretched between two layers of an elastic medium, the air without and that within the cavity, the membrane receiving its oscillations from the one must freely communicate them to the other; those excited in the inner stratum of air may react upon the membrane; which, thus vibrating between the two powers, might not be well adapted to receive the new impulse in continued though varying sound: hence it is more than probable, that the membrane is merely returned, by the reaction of the air in the tympanum, to its condition of quiescence. The ossicula auditus, with their ligaments, forming an elastic chain, are well arranged to

receive the motions from the membrane, and the impulse having been conveyed onwards to the labyrinth, they will react upon the membrane to the degree only of normal replacement. Thus, an excellent provision appears to be made, to prevent the membrane being driven too far outwards, and to preserve it in a condition to be influenced by new sounds, as rapidly as they can be conveyed to it. This membrane therefore is a drum-head modified, and, like that instrument, has a mass of air, occupying the interior, furnished with an aperture, the Eustachian tube, probably for recession; and, like the drum-head, it can be tightened or relaxed, possessing however the very great advantage of its relaxation or tenseness varying according to the note falling upon it, and as rapidly as it receives it. It is most likely that the number of vibrations of which the membrane is capable vary at least from 16 to 24,000 in a second, as such a variety of vibrations of a chord can be distinguished; and it is further probable, that many slower or more rapid oscillations of this structure may occur, which do not produce an appreciable effect. Of course, the muscles have an important influence in adapting the membrane to this great variety, as this power depends upon its degree of tension. It appears that when the mind is intent upon catching every minute impression, the tensor tympani and the stapedius, by drawing the ossicula inwards, give tension to the membrane, and thus fit it to receive the slightest influence. On the contrary, when the note is oppressively loud or discordant, the laxator tympani, aided by the levator tympani, relaxes the membrane, and thus lessens its vibrativeness.(*a*) Professor Wheatstone

(*a*) Müller (*op. cit.*, p. 756) has proved, by a variety of experiments, that a moderately lax state of the membrana tympani is more favourable to the transmission of sound than when it is very tense. A great tension of the membrane causes, however, as Dr. Wollaston has shown, chiefly deafness in grave sounds.

"These facts," says Müller, "admit of a practical application in pathology. It is not very rare to meet with persons who are deaf to the more grave sounds only, while they still hear distinctly acute sounds, even though they be not loud. One of my

has said, that the complete tension of the membrane will limit, if not remove its power of vibration, and that consequently in sounds, which would be productive of danger to the organ, or unpleasantness to the mind, the tensors are in fullest action, and the impression is prevented. It has been noticed that this does not harmonize with the general opinion, and unfortunately the Author cannot place his hand upon the experiments upon which the Professor founds his conclusions. Do the muscles act in consequence of the impression communicated to the brain, which then transmits to them its volition? It is imperative that sensation shall be first perceived by the sensorium — is this in fact a mental action, excited for the protection and function of the membrane? Without entering upon the interesting question of muscular action, we may yet be permitted to state what appear to be facts, susceptible of satisfactory proof. The otic ganglion was imagined by its discoverer, Arnold, to influence those muscles in a manner similar to that which the lenticular exerts upon the iris, and doubtless this is correct; but if he implied, which he appears to have done, that this influ-

colleagues, who is deaf, hears acute better than grave sounds. In such cases it is very probable that the membrana tympani is in a state of too great tension. In the present state of obscurity of the diagnosis of diseases of the ear, this hint may be of some use. Such unnatural tension of the membrana tympani may, of course, be produced by several different causes. It may arise from occlusion of the Eustachian tube; in which case the air in the tympanum may either be expanded by the heat of the body, and so force outwards the membrana tympani, or it may be partially absorbed, when the membrane would be pressed inwards by the air without. Another cause may be a contracted state of the tensor tympani muscle. In my colleague the Eustachian tube is free, for he can force air into the tympanum. When the Eustachian tube is closed, and the tension of the membrana tympani is the consequence of the expansion or partial absorption of the air in the cavity of the tympanum, the operation of puncturing the membrane, or the mastoid process, may be easily conceived to be beneficial; but when the too great tension of the membrana tympani, and consequent deafness, are owing to a contracted state of the tensor tympani muscle, the operation must be useless. This may in part account for the various results obtained from it."

ence was exerted through the sensorium, he was certainly in error, as the recent investigations of Dr. Marshall Hall, and Mr. Grainger, have proved. As in every other structure of the body capable of receiving an impression, so are those upon the membrana tympani transmitted by the incident nerves to the grey matter of the otic ganglion; this, being a seat of nervous power, is excited, and communicates its influence, by the reflex motor nerves, to the muscles either of relaxation or tension as may be required, thus a most important action is brought about quite independent of the will. Again, by the medium of the nerves of common and peculiar sense, an impression is conveyed to the sensorium, upon the perception of which volition is communicated to the muscles by means of the portio dura, which are then excited to action in consequence of the operation of the mind. This double mode of action corresponds with the function of every muscle, there being two distinct exciting causes, one physical and independent of the mind, the other mental and occasioned by volition. By this beautiful and simple arrangement, the protection of the organ is placed beyond our control, and at the same time means are afforded us for influencing its functions to our own conveniences.

In reflecting upon the physiology of the membrana tympani, it is interesting to recollect that its chief muscle, the Tensor Tympani, is largely supplied, both from the otic ganglion and the portio dura, which circumstance alone would lead to the comprehension of its great utility. It is more than probable that the membrane, by these means, is brought into a state of unison with the sounding body, whatever that may be; and that if the attention be directed to a particular sound, the membrane being out of unison with other noises, they do not occasion that interference and confusion which otherwise would result. The late Mr. Swinburne carried this idea still further, by imagining that as each fibrous elevation of the membrane must, for the reasons before stated, differ from all the others in length, and it is possible even in density, it forms a musical chord of a particular note, the vibrations of which will only respond to a corresponding note; and thus he ingeniously accounts for the circum-

stance of many sounds varying in note, quality, pitch, &c., being distinctly perceived at the same time by the mind, and without much if any confusion. In this manner the membrana tympani, receiving an exact impression of the vibrations of the sounding material, transmits them to the malleus, and possibly also to the air contained in the cavity.

The *Ossicula* are so articulated that they form not only a vibratile, but also an elastic chain, and being firmly articulated to each other, are admirably arranged to transmit the rapid and tremulous motions from the membrana tympani to the membrana fenestræ ovalis. They assist also in increasing the power of the impression, as nearly the whole vibration of the membrane is concentrated in the manubrium of the malleus, and is further augmented in its head by virtue of its leverage; this augmentation of vibratory power is still increased in its transmission along the different levers, and at last is condensed upon the membrane of the oval opening, which thus, small as it is in comparison with that of the tympanum, receives the same influence much augmented; this increased vibration is thence transmitted to the fluid of the vestibule. The degree in which these small bones are useful in this process has been variously stated; some physiologists, imagining that they are of secondary importance in transmitting the oscillations, and others, in which opinion the writer concurs, considering them the chief means of occasioning the undulations of the aqua labyrinthi. It is true that the ossicula, not even excepting the stapes, may be lost, and hearing still continue, but the function is then imperfect, and the more minute sounds are imperceptible, a much greater influence being required when the impression is made directly on the stapes, or on the membrane of the fenestra ovalis, to throw it into vibration, than when the bone or membrane is influenced through the natural means. If this argument is to be admitted, by the same reasoning we must suppose that the membrana tympani is of little importance, for when the bones are lost the membrane must be absent also; and not unfrequently it happens that the great bulk of the membrane may be removed by ulceration, leaving only sufficient

to support the malleus, and yet the function may be but very little affected: and as a tympanum in its normal state is never met with in the animal series unaccompanied by the ossicula, or an ossiculum, there is reason to believe that they constitute the most important part of the middle Ear. Most probably it is through the agency of these small bones that the infinitely delicate, minute, and rapid vibrations of the membrane of the tympanum occasioned by speech, music, and all slight sounds following in quick succession, are increased sufficiently to produce effective undulations in the labyrinth; thus, therefore, there is great reason to esteem the middle as the musical portion of the Ear. Savart concludes his observations upon the ossicula by saying, "In fine, I believe that the chain of small bones is to the Ear the same as the bridge to the violin."(*a*)

(*a*) "The ossicula of the ear are the better conductors of the sonorous vibrations communicated to them, on account of being isolated by an atmosphere of air, and not continuous with the bones of the cranium; for every solid body thus isolated by a different medium propagates vibrations with more intensity through its own substance than it communicates them to the surrounding medium, which thus prevents a dispersion of the sound, just as the vibrations of the air in the tubes used for conducting the voice from one apartment to another are prevented from being dispersed by the solid walls of the tube. The vibrations of the membrana tympani are transmitted, therefore, by the chain of ossicula to the fenestra ovalis and fluid of the labyrinth, their dispersion in the tympanum being prevented by the difficulty of the transition of vibrations from solid to gaseous bodies. The membrana tympani being a tense solid body bounded by free surfaces, the sonorous undulations will be partially reflected at its surfaces, so as to cause a meeting of undulations from opposite directions within it; it will therefore, by resonance, increase the intensity of the vibrations communicated to it, and the undulations thus rendered more intense will act in their turn upon the chain of auditory bones."

"The propagation of sound through the ossicula of the tympanum to the labyrinth must be effected by undulations of condensation and rarefaction of their particles only, not by oscillations of the entire bones, even in cases where the entire membrana tympani oscillates; for, if the stapes were in its vibrations alternately more nearly approximated and removed from the laby-

It is necessary to allude to other influences which are exerted by the tympanum. Many physiologists regard the air of the cavity as the chief means of transmitting the vibrations from the membrane of the tympanum to the labyrinth, by exciting similar oscillations in the membrana fenestræ rotundæ; the use of the ossicula, according to this theory, being principally limited to supporting the membrane, and in some degree to assist in affecting the labyrinth through the medium of the fenestra ovalis. In this manner the supporters of this opinion account for the loss of the bones being unattended with what may be considered to be a corresponding loss of audition; and for the use of the extension of the tympanic cavity, by its communication with the cranial cells. In this argument, however, it appears to be forgotten that the loss of the stapes is generally attended by complete deafness, as far as concerns the tympanum; that the membrana fenestræ rotundæ is disadvantageously situated to receive the fullest influence from the air of the tympanum; and that the communicating cells are fewer and smaller in man than in most other animals, though he enjoys the nicest discrimination of sounds, far surpassing that even of birds. It is nevertheless probable that the elastic air may act upon the membrana secondaria, or membrane of the fenestra rotunda, and thus assist in producing the undulations in the scala tympani; yet to the writer it appears more consonant with the arrangement of the cochlea to suppose, as will presently become more apparent, that it merely restores the membrane to its natural condition of quiescence, when it has been thrown into a state of oscillation by the fluid within; that, in fact, the air influences the two membranes, that of the tympanum, and that of the round opening, in a like manner, though acting upon the inner surface of the one, and the outer of the other, maintaining a pressure upon both equal to that which opposes it, thus affording each an opportunity of freely oscillating.(*a*)

rinth, the fluid of the latter cavity must necessarily be very compressible. The extent through which the individual particles affected by the undulations oscillate equals very minute fractions only of the length of the stapes." (Müller, *op. cit.*, p. 754–5.)

(*a*) "The necessity for the presence of air on the inner side

The atmosphere contained in the tympanum becomes rarefied by the temperature of the part, for in proportion as it becomes expanded by the heat, it may be absorbed, and as it will consequently cease to afford the requisite counter-pressure, and suffer a diminution in its capability of vibrating, a constant renewal of fresh air is demanded;

of the membrana tympani, — in other words, the necessity for the existence of the tympanic cavity, — to enable the membrana tympani and ossicula auditus to fulfil the objects which we have described, is obvious. Without this provision neither would the vibrations of the membrane be free, nor the chain of bones isolated, so as to propagate the sonorous undulations with concentration of their intensity. But while the oscillations of the membrana tympani are readily communicated to the air, in the cavity of the tympanum, those of the solid ossicula will not be conducted away by the air, but will be propagated to the labyrinth without being dispersed in the tympanum. Equally necessary is the communication of the air in the tympanum with the external air through the medium of the Eustachian tube for the maintenance of the equilibrium of pressure and temperature between them." (Müller, *op. cit.*, p. 755.)

As respects the relative importance of the sonorous vibrations made in the two fenestræ, Müller holds the following language: —

"We may express the problem to be decided in other words, thus: By which succession of media is the intensity of sonorous undulations least diminished? — by air, a tense membrane, an insulated and moveable solid body, and water; or by air, a tense membrane, air, another tense membrane, and then watery fluid? The experiments which I have instituted prove very clearly that —

"Vibrations are transmitted with very much greater intensity to water when a tense membrane, a chain of insulated solid bodies capable of free movement, are successively the conducting media, than when the media of communication between the vibrating air and the water are the same tense membrane, air, and then a second membrane; or, to apply this fact to the organ of hearing, that the same vibrations of the air act upon the fluid of the labyrinth with much greater intensity through the medium of the chain of auditory bones and the fenestra ovalis, than through the medium of the air of the tympanum and the membrane closing the fenestra rotunda.

"I imitated the structure of the tympanum and reached the above result by direct experiment." (p. 759.)

this is readily effected through the medium of the Eustachian tube, the closure of which is invariably attended with a loss of the function of the tympanum. It is very probable also that a slight recession of the air may take place, from the cavity along the tube corresponding to each vibration of the membrane; — to entertain which opinion it must be supposed that the oscillations of the membrane are too rapid for the elasticity of the air. In consequence of the large size of the tube in the reptile, — its communicating with the blow-hole of the whale, — and deaf persons frequently opening their mouths when in the act of listening, it has been imagined that in man sounds may pass by this mode also into the Tympanum and excite Hearing. The truth of this supposition is more than doubtful; were the sound to proceed in this direction, it would strike upon the inner surface of the membrane, and oppose its natural action; and the anatomical arrangement will not permit the belief, that the small bones can be influenced without vibration of the membrane; and in order that this effect may occur in the whale, the bones are *indirectly* attached to the membrana tympani. Richerand has accounted for the well known fact of individuals who are deaf, opening the mouth when intent upon Hearing, by supposing that the depression of the jaw expands the meatus; this enlargement, however, if it occur at all, is very slight, and can have but a very limited influence. The writer has noticed that persons deaf from accidental disease of the external or middle ears, rarely thus open their mouths; and as deafness from loss of function of the nerve, is frequently connected with deficient mental capacity, this symptom may perhaps be attributed to the same cause. The fact of the Eustachian tube constituting an excretory duct to the tympanum has already been alluded to.(*a*)

(*a*) "The principal object for the fulfilment of which this tube exists, wherever there is a tympanum, appears to me," says Müller, "to be the maintenance of the equilibrium between the air within the tympanum and the external air, so as to prevent inordinate tension of the membrana tympani, which would be produced by too great or too little pressure on either side, and the effect of

It is difficult, perhaps impossible, to attribute an use to the mastoid cells, to which an objection may not be easily raised; it is thought that they allow a reverberation of the air, and thus add to its effect upon the membranes; and this is particularly the opinion of those who consider the air as the conducting medium from one membrane to the other. It seems probable that, as regards the Ear, their chief use is to contain a large quantity of air, which is thus prevented from becoming too rapidly rarefied; reverberation may also aid in the performance of the functions already noticed. There cannot exist a doubt that the cells are beneficial, and in birds particularly so, by lessening the specific gravity of the bones; and affording increased surface for muscular attachments.

We have thus traced the influence of sound to the fundamental portion of the organ, in which we find that vibrations are excited in the two membranes of the fenestræ. It has been long imagined that the membrane of the oval opening set into action by the ossicula, and that of the round opening by the air of the tympanum, directly communicate their oscillations to the aqua labyrinthi, which is in immediate contact with their inner surfaces; and if it should be asserted that a sac of the liquor intervenes between the fluid and the membrane, the effect would be still unaltered. No doubt can exist that the first, and perhaps the most important, undulations take place in the

which would be imperfection of hearing. It is not the increased or diminished density of the air on either side of the membrane which is of the chief importance, but the tension of the membrana tympani which they necessarily produce, and which always interferes with the integrity of hearing.

"It is on this principle that we must explain the good effect of catheterising the Eustachian tube, or of perforating the membrana tympani, or mastoid process of the temporal bone, in many cases of deafness caused by chronic occlusion of the tube. While, however, I maintain that this is the principal office of the Eustachian canal, I do not deny that it has other uses, of which the next in importance appear to me to be the modification of the sound so as to render it more clear, the supplying the tympanum with air, and the discharge of the secretion of that cavity." (p. 760.)

vestibule, and as the large sac of this cavity is in direct contact with the membrane of the fenestra ovalis, another reason is afforded to presume that its influence is much greater than that of the fenestra rotunda. The fluid of the vestibule is thus agitated into undulations, most likely exactly corresponding to the vibrations of the membrane. And if it be a fact, that the vestibule contains two cretaceous bodies suspended by nervous fibrillæ, they must still further influence the fluid, at the same time that their oscillations must produce an effect immediately upon the acoustic nerve. These waves extend around the semicircular canals, commencing from, and terminating in, the sac of the vestibule; it is impossible to ascertain the course of the undulations along the canals, but judging from the analogy of the cochlea, they probably commence at the narrow aperture, and terminate in the ampullæ; and thus it will happen, that meeting with the agitated water of the vestibule, increased undulations will occur in the enlargements, corresponding to the greater quantity of nervous filaments there distributed.

It has been generally stated that similar undulations, taking their course from the vestibule along the scala vestibuli of the cochlea, and from the membrane of the fenestra rotunda through the turns of the scala tympani, meet in the canalis scalarum communis, and immediately arrest each other. But from what has preceded, it will be collected that the author concurs rather in the view of Sir Charles Bell, that all the undulations are conveyed through the medium of the vestibule; and that from its smaller sac they are taking the course of the scala vestibuli, passing through the common canal, and again descending from the apex to the base of the cochlea, along the scala tympani, and at length strike upon the inner surface of the membrana secondaria, which yields in proportion to the power of the wave against it. In a manner somewhat similar to that in which the water contained in the ampullæ of the canals is affected, the membrane, vibrating, influences still further the fluid in the much expanded base of this scala. Thus is scientifically accounted for the recession of the fluid necessarily consequent upon its undulations: in the same degree as

the membrane of the fenestra ovalis is driven inwards, that of the rotunda is forced outwards, and the vibrations of both corresponding, the effect is maintained so long as the cause is applied. Cotunnus, and after him many other physiologists, believed that the fluid receded into the aqueducts named after that anatomist, but which are now ascertained to be veins; as they are, however, somewhat unusually large, it is possible that under extraordinary circumstances of over-accumulation of fluid, or excessive undulation, a very small quantity may flow into them.

The aqua labyrinthi flowing thus over the highly nervous membrane excites an impression which is conveyed by the acoustic nerve to the brain, and perception of the sound is the consequence. As the nerve in the semicircular canals is expanded between two columns of fluid, it is evident that it must be there more influenced than in the cochlea; but the precise modification which these curiously curved tubes, constituting the labyrinth, produce, is not known: that they are subservient to perfect hearing, and particularly to the discrimination of minute sounds, is certain, but to what amount will perhaps ever remain an unsolved problem.(*a*)

Thus, at last, as in the lowest animals, so in the highest, hearing is merely a very delicate and elaborate modification of feeling; the pulp of the auditory nerve is mechanically affected by the water, which contact the brain feels; but the impression is so far removed, by its extreme delicacy, from the common sensation of touch, that it appears to be another sense, requiring another term.

A question may be here proposed: — Is this impression communicated to the brain by other means than those above stated? Most probably it is not; for though a watch applied to the teeth or to the skull will excite sensation in a person said to be deaf, yet it is most likely that the labyrinth is healthy, and consequently the vibrations are received by its fluid, the disease being seated in the outer or the middle Ear. The portio mollis in the

(*a*) See Müller, p. 765–8.

internal meatus, or in the skull, before its expansion into its pulpy matter, may, although it is hardly probable, be capable of receiving and communicating the impression, without the assistance of the rest of the organ; but there is little or no doubt that the sensation which is perceived in cases of complete nervous deafness through the medium of the skeleton, is rather to be considered as the product of the common nerves of feeling.

The connection existing between the Portio Mollis, Portio Dura, Portio Media, and Ganglion Oticum, can be better accounted for by considering it necessary to sympathetically combine the functions of the muscles and other structures of the tympanum with that of the nervous expansion of the labyrinth, than by adopting Mr. Swan's supposition, that the facial nerve can receive and transmit sound to the auditory.

The benefit consequent upon our being furnished with two ears is, in addition to the general advantages of all the animal organs being double, that we may the better ascertain the direction of the sound, and thus more accurately be informed of the situation of the sounding body.

As certain colours do not impress the retina sufficiently to be perceived by the brain, so certain sounds, according to Dr. Wollaston's interesting investigations, are inaudible to some persons, although readily heard by others. These are especially the lowest notes, and which he appears to attribute to a partially exhausted state of the tympanum, in consequence of which the external air presses forcibly upon the membrane, and its vibration is only to be procured by sound more or less sharp. This constitutes a species of partial deafness, in which the person hears the voice when raised to a higher pitch, though it may not be louder than before.

Different persons have also various limits to their extent of hearing; thus many very acute sounds, as the chirping of some insects, though generally producing an effect in persons with ordinary hearing, can never be perceived by others.

This limitation in many instances may depend upon some deficiency in the organ itself, and frequently upon

a lessened sensibility of the nerve; yet in very many cases it must be attributed to an incapacity in the sensorium to perceive an impression so slightly made.

By frequent use and great attention to musical sounds, without doubt, the organ, and especially the small muscles and the acoustic nerve, may become more active in its functions; but the condition, which has been termed "the good Ear for music," is to be referred to a superiority of that mental faculty which, readily perceiving the impression, is capable of associating and comparing the rapid notes, and forming a judgment of their harmony or discord.

PART II.

ON THE ABNORMAL CONDITION OF THE EAR.

In considering the variations from the ordinary structure, and healthy state of the Ear, it is purposed to treat first of the malformations which have been observed, with their treatment, to the slight extent that has been hitherto found capable of application; and then to describe the diseases, properly so called, or the deviations from the healthy state of the organ, originally well-formed.

MALFORMATIONS OF THE EAR.

In consequence of the study of developmental anatomy, it has been ascertained that most of the malformations to which the different organs are liable, ought more strictly to be considered as deficient formations; that the structures having proceeded to a certain extent, from

some cause, occasionally suspected, but much more frequently not, the organization ceases to extend, and the part remains partially formed, while the rest of the animal may be completed. The incompletion may affect an entire organ, or only a part of the apparatus, the rest being normal. Although this is the general mode in which malformations occur, it is very certain that organs, entire or in part, are occasionally improperly constructed; and in many instances, that there is an exuberance of formation; in both cases constituting what may more properly be termed *Lusus Naturæ*.

In noticing the most frequent deviations in the formation of the human Ear, it will be apparent that they do not differ from the general law, and that most of them must be viewed as deficiencies. And as different portions of the organ, at different periods of formation, bear an analogy more or less striking to similar parts in the lower animals, so it is easy to trace in their malformations a correspondence to the permanent structure of the inferior classes. Such being the real character of the so-called malformations, it will be advisable to premise their history with a slight sketch of the formative process in the several parts of the auditory organ.

The *Auricle* is first perceived about the middle of the second month of fœtal existence; when it presents a very small elongated triangular eminence, the base above, the apex below, and not separated from the skin of the face and head: it has a longitudinal depression, becoming narrower and deeper from above downwards. In a short time the posterior margin is elevated, and projects from the side of the head, eventually to form the Anti-helix. About the same time a transverse slit divides the anterior portion into an upper part, forming the commencement of the Helix, and a lower to be converted into the Tragus. Early in the third month the Anti-helix and Anti-tragus are developed. The Lobus is the last part which makes its appearance. During this formation the anti-helix is more apparent and projecting than the rest, in consequence of the tardy growth of the posterior edge into the helix. The entire auricle is particularly small in proportion to the size of the fœtus. Its cartilage begins to be deposited

about the third month, and so slow is its progress that it is hardly completed at birth.

The malformations of the auricle most frequently met with are : —

1st. A deficiency of the Helix, usually of the posterior part, and sometimes its division from the lobus. It is not at all uncommon to see the helix so very small and flat, and so nearly concealed by the anti-helix, as hardly to deserve to be accounted as a distinct process. Such a limitation of its growth is sometimes the consequence of the pressure of the dress; which may, however, in general, be readily distinguished from original deficiency. The horizontal portion of the helix frequently extends backwards to the anti-helix, and being then very prominent completely divides the concha into an upper and lower depression.

2d. An entire absence of the Lobus now and then occurs, resembling the natural condition of the early formation. More frequently it happens that it is attached wholly or partially to the integument of the side of the head. And occasionally it has been found divided by a slit into an anterior and posterior portion.

3d. The Tragus and Anti-tragus have been seen united more or less extensively, particularly at their lower borders, so as partially to close the opening of the meatus. They are also sometimes inverted towards the canal, producing the same effect. One or both of these bodies are occasionally divided into two portions.

4th. The total absence of the auricle has been several times reported, by Meckel and others. Mr. S. Cooper, in his valuable dictionary, relates a case which he and many other surgeons saw, of a child entirely destitute of all appearance of external Ears, and with no vestiges of the meatus auditorii, these openings being completely covered by the common integuments; the child, however, could hear tolerably well.

5th. An enormous enlargement of the outer Ear, may be enumerated as one of its malformations. An increased size is often the result of manipulation, or the dress stretching the part; but it also occurs as an original con-

formation. An unusual pendulous growth from the lobe or any other part, may be readily removed.

Of these deviations, the absence of the auricle, and the closure of the opening will alone require surgical aid. The former appears to lessen, but slightly, the power of hearing, and the deficiency can only be supplied by an artificial Ear, as a cornet of metal, resembling in shape the auricle. And probably even this aid may not be required, as in proportion to the loss of one part of an organ, the rest, if healthy, has its capabilities augmented by increased exercise. The overlapping of the tragus and antitragus, if prejudicial to hearing, may be readily removed by the knife; or if it be of small extent, dilatation by the gentle pressure of a tube or a tent may be sufficient.

The *Meatus Auditorius Externus*, the rudiment of which is also evinced about the second month, is entirely cartilaginous for some time after birth, and during fœtal life, like the auricle, is especially narrow: it is formed from deposits in several points. At this period the cartilage is attached to the margin of the petrous bone, immediately supporting the membrane of the tympanum. The osseous portion is a subsequent development of the processus auditivus, beyond the attachment of the membrane. As in the fœtus, the membrane of the tympanum is much more oblique than afterwards, the reflection of the skin is proportionally much more extensive along the inferior than the superior surface of the meatus: in fact, it can hardly be said to exist above, but is particularly extensive, and folded below: it is generally also thicker and softer than in the adult.

From this mode of formation, it must be anticipated, that the most frequent variations will be —

1st. A very narrow canal; indeed, its diameter is observed to vary from the ordinary size to complete obliteration of the tube. The meatus of different individuals, all considered normal, vary in size and depth; a merely contracted canal, and even when of undue length, not interfering with audition. Contraction to such an extent as not to admit a probe, must, however, importantly impair

the function, as in a case related by Leschevin; and if the canal should be completely closed, deafness must be the result.

2d. A closure of the opening of the meatus by the integument stretched across it, and attached to its margin, resembling an imperforated anus. A similar imperforation is described as occurring in any part of the canal, either by a portion of the lining membrane; or, what is of much greater consequence, by a contraction in that particular part of the cartilage; or even by an undue ossification of the bony portion of the tube.

3d. Some few cases are recorded of a total absence of the meatus; as that related by Mr. Cooper. Of the few examples of this kind, there has been in the greater number a deficiency of the whole organ, the want of the outer Ear being only a part of the general non-development.

4th. The writer occasionally examines the meatus of a girl, (who has been some time deaf in the opposite ear,) which is unusually short and large, with a membrane corresponding in size; she declares that hearing is perfect in that ear, though, from the attention with which she listens to the voice, the contrary might be inferred. Such a condition has been alluded to by authors, and by Itard in particular, as a malformation; and an extreme case of the kind might doubtless be so considered. The defect is only to be alleviated by the patient wearing a conical tube; and it may be advantageous to have it slightly curved, something resembling the obliquity of the meatus.

5th. Cases are occasionally occurring, in which the meatus at birth is completely filled with the slimy caseous matter, which often covers the general surface of the infant, and which may be either deposited from the liquor amnii, or it may be a defensive secretion of the sebaceous follicles; if this matter be allowed to remain, the deafness which was at first undiscovered, may become permanent, from the inactivity of the organ, and extreme hardness and fixity of the matter in the meatus. As this cause has been known to produce congenital cophosis, it behoves the practitioner carefully to examine the audi-

tory canal in all cases of birth, the matter being most easily removed while it continues moist.

The *surgical means* to be employed in such states are very apparent. The introduction of tents, or silver tubes, gradually enlarged to the normal size of the meatus, will generally succeed in distending the canal; as in most instances there exists rather a malarrangement of the cartilaginous fibres than an absolute deficiency. If this effect cannot be accomplished without danger of producing too much excitement, the patient must be satisfied with what aid acoustic instruments can afford him.

In the more important instance of obliteration of the canal, either throughout its entire length, or in part, if the Surgeon has reason to expect that the organ is normal from the membrana tympani inwards, he doubtless will be justified in the attempt to form an artificial opening. This may be effected by the gradual introduction of a very small trocar, or by division with a very narrow knife, as nearly as possible in the natural oblique direction of the canal; and afterwards maintaining and increasing the diameter by tents or tubes. In the unhappy cases where there is good reason to suspect that the malformation extends to the internal organ: or where the obstruction is resisting and solid, and particularly if it be osseous; the patient must be left to his fate, and if it occur on both sides, is incurably deaf; for the idea that, in such a case, it is possible he may ever hear through the Eustachian tube, if it should exist, is quite puerile. A tolerably good opinion may be formed, though certainly not a perfect one, of the capability of the labyrinth to be influenced by sound in cases of closure of the meatus, by exciting vibrations in the cranium or in the facial bones, through the means of a watch, or of a wire thrown into a state of oscillation, brought into contact with the head or face. And much information may be obtained as to the condition of the cavity of the tympanum by sounding through the Eustachian tube.

A fold of skin across the opening, or of the lining membrane in any part of the tube, may be readily rectified by division with the lancet or narrow knife, or by perforation with a trocar, if the passage be perfect behind it.

The *Middle Ear*, in its development, is well worthy the physiologist's study, as the greater number of the malformations of its component parts are the fœtal conditions permanently retained; and at different periods the analogies to the structures in the lower animals are more or less prominent.

The *Tympanum* appears to be originally formed in connexion with the temporary branchial arches; Rolando, a very high authority, regards it as a pushing out of the mucous membrane of the Pharynx: but then he knew nothing of the branchiæ of mammalia.

The cavity is proportionately smaller and narrower in the commencement of fœtal life than at subsequent periods; a state which corresponds to the small size of the mastoid-process, and the non-development of its cells. It is remarkable that the cavity is filled with a thickish gelatiniform matter, which occasionally remains after birth. The Eustachian tube is very short and broad, and opens almost immediately into the fauces, corresponding to the permanent condition in the amphibia. At the middle period of fœtal life, the cartilaginous portion is membranous; and at birth the osseous portion is still incomplete. The outer margin of the tympanum, and the membrane attached to it are large, not only in proportion to the outer Ear and the head, but also to the whole body; and the younger the fœtus the more striking is this peculiarity. The membrane is also much nearer the surface, in consequence of the deficiency of the osseous part of the meatus; and as the membrane is now much more oblique than in after-life, even approaching the horizontal position, so its upper margin is nearer to the opening of the meatus, which temporary arrangement somewhat resembles the permanent condition of this part in the reptiles.

The *Ossicula Auditus* are remarkable for the early completion of their ossification, being indeed the first bones perfected in the body. Even at the beginning of the third month they may be distinguished,— as yet, however, altogether cartilaginous; at the fourth month the malleus is three lines in length, while the trunk of the fœtus being four inches, its proportion to the body is as

one to sixteen, whereas, in the adult, according to Meckel, it has a proportion of one to ninety. These little bones are as large at birth as in after life. It appears, from the observations of Meckel and the subsequent researches of Valentin, both of which differ in certain points from those of some other anatomists, that the ossification of the malleus and incus has proceeded to some extent while the stapes remains cartilaginous. The process certainly begins in the long crus of the incus, which becomes ossified earlier than the posterior. Its commencement in the stapes has been variously stated; by some it is regarded as beginning at the head, and extending along the crura to the base, whereas Meckel has never seen it to commence at the head, but sometimes at the lower part of the posterior crus, sometimes at the base. In the malleus ossification appears to begin in the head.

It is more interesting, however, to notice the changes which take place in the bones during their development. The incus hardly undergoes any alteration, unless, as described by Huschke, and confirmed by Valentin, its posterior crus is, in the very early period, connected with the os hyoides, and perhaps also with the styloid process, in a manner similar to the union of the malleus with Meckel's process. In the commencement the Stapes is not divided into two crura; it is a little solid bone, resembling that of the cetacea, and the inner portion of the columella of reptiles; the opening between the processes and the base is gradually formed, being at first merely a depression, and remaining proportionally narrow for some time. The malleus is remarkable above all the other bones of the body by the changes consequent upon its development. In the early period, according to Meckel, it possesses "a straight cartilaginous apophysis, of the form of an elongated cane, and which is both very long and thick in proportion to the rest of the bone. This apophysis proceeds from the anterior part of the head of the bone, passes out of the cavity of the tympanum, between the petrous portion and the margin for the membrane, and applying itself directly to the inner surface of the lower jaw, it extends to the anterior extremity of that bone, where the process sometimes, and perhaps always,

unites with the corresponding one of the opposite side. This cartilage is never ossified, although at this period it forms the great mass of the bone; and it disappears at the eighth month. The processus gracilis, to a certain extent, corresponds in situation to this process; but as both are perceived at the same time in the fœtus, and the cartilage being above the process, they are very distinct from each other. This cartilage, (which is termed, after its first describer, 'Meckel's process,') is very remarkable in fishes; reptiles and birds possess a similar appendage, which extends from the posterior portion of the lower jaw to the anterior. In these animals it lies upon a little bone situated on the inner surface of the posterior piece of the inferior maxilla, and it is considered as a rudiment of a malleus." This temporary apophysis has doubtless led Geoffroy Saint Hilaire to describe the opercula of fishes as rudimentary ossicula auditus, as they hold a somewhat similar position; and from the investigations of the German anatomists, it seems nearly proved that it is in the same situation during a short period of fœtal existence, forming a part of the temporary branchiæ.

The malformations of the tympanum which have been recorded are not numerous, but of the utmost importance, as most of them are attended with deafness, and the cause is generally not to be removed.

1. The cavity has been found much smaller than usual, retaining its early fœtal character. It may be conceived that this condition, provided the appendages were normal, might not give rise to deafness, though it would be expected to diminish materially the power of hearing.

2. Itard and others have described the outer wall as being ossified, in fact, that the bony plate has occupied the place of the membrana tympani. It is evident that such an unhappy formation must produce incurable deafness.

3. The opposite condition of inordinate amplitude of the cavity is also reported to have been seen, of which cophosis was the consequence.

4. More frequently occurring variations in conformation than the above are to be met with in the *ossicula*.

They have been found too small for the performance of their proper function by Bernard. Meckel states them to be sometimes of extraordinary dimensions, retaining the *relative* large size of the fœtal period. They more commonly vary as to their shape, approaching more or less that of other animals. The Malleus has been seen abnormally long; and again too short; or with its processes unusually large. The Incus has also been found too long, or too narrow; its long crus has been seen arched, and its short crus deficient. But the Stapes is most frequently recorded as malformed, probably partly in consequence of anatomists having directed their attention to that bone rather than to the others, but especially no doubt from the mode of its formation tending to produce more frequent varieties. Comparetti found, in a man, both stapedes, not only very small, but each composed of a single crus, with a very small base closing an equally small fenestra ovalis. Rudolphi and Læsuke have described, and the former figured, a stapes with one crus communicating with the base, the other projecting out, forming with it an obtuse angle. The celebrated Tiedemann found in a new-born infant a stapes without branches or aperture; it resembled a little pyramid slightly depressed in the centre, and was in the usual manner attached to the incus. The same acute anatomist has seen this bone in an adult with its two crura united by a bony layer, producing a slight depression, but no opening between them. And Cruveilhier met with a stapes extremely small, and another in which the two cura were united.

These variations bear strong analogies to the natural conditions at some period of the development; which fact is particularly to be recognized in the stapes. It may readily be comprehended how most of such varieties would be of little consequence to the function; and that others, — as the incus, not being steadied by its short crus, — or the malleus too large, or its processes too long for perfect vibration,— would occasion difficulty of hearing; and again, that the stapes being extremely small, or all the ossicula either being inordinate in size, or too diminutive, may be causes of incurable deafness.

The bones of the tympanum have been found ossified together, and the stapes to the fenestra ovalis; such a circumstance will rather be caused by inflammation occurring after birth, or by excessive development during their growth, than by a vicious conformation; the former condition is not necessarily attended by cophosis.

It is not common to find the bones deficient; a case is however reported in the *Dictionnaire des Sciences Medicales*, in which all the ossicula were wanting; and Mersanni found the incus absent, which produced deafness; whilst, on the contrary, Caldani reports a case of deficient malleus and incus, from which but little inconvenience arose.

It is very rare to find supernumerary bones; when they have existed they have been very small, and placed between the malleus and incus; and one has been seen upon the neck of the stapes.

5. In a case of congenital deafness, the tympanum has been found filled with a softish white matter, something resembling inspissated albumen, and supposed to be secreted from the mucous membrane, and too thick to escape by the Eustachian tube. The cavity has been occupied likewise by a scrofulous deposit, occurring during its development. Mr. Cock in dissecting the Ears of five children who had died in the Deaf and Dumb Asylum, found in one the tympanum, together with the mastoid cells, completely filled with the thick cheesy deposit of scrofula, whilst a similar affection pervaded the whole cancellated structure of the petrous bone. The connections of the ossicula auditus were destroyed, but the bones themselves remained entire. Mr. Cock does not suppose that this deposit could have had any connection with the congenital defect in the organ of hearing, as he imagines, it existed but a short time previous to death.

6. Congenital obliteration of the Eustachian tube, which is so essential an appendage to the tympanum, must be esteemed as an important malformation of the middle Ear. The Writer has neither heard of, nor read many reported cases of this nature; yet, is it probable that some instances of congenital Dysecœa, having for its unfortunate concomitant dumbness, may depend upon the

tube being originally closed, either in the cartilaginous or osseous portion; or so much smaller than its natural diameter, as to transmit a volume of air insufficient for the necessary purposes. Sir A. Cooper, in the Philosophical Transactions, has mentioned the case of "Mr. John Round, seventeen years of age, who was deaf from birth to a degree to incapacitate him from engaging in business. He had an imperfect state of the fauces which rendered him incapable of blowing his nose; the Eustachian tubes had no openings into the throat, he could not therefore force air from the mouth into the Ears. The auditory nerves were perfect, for he distinctly heard the watch, placed between the teeth, or against the bones of the head, and never had a buzzing noise in the Ears. The operation of puncturing the membrane of the tympanum was had recourse to, when a new world was immediately opened to him; the confusion produced by the number of sounds nearly overpowered him: finding hearing was restored on one side, he wished to have it performed on the other, which was done with the same happy results. Two months after he wrote that he had no relapse, and his hearing was perfect."

Unfortunately, however, it is rare that surgery can afford relief in these abnormal formations. The very existence of the deafness in many instances is not discovered until the acoustic nerve has to a great, and sometimes to an irreparable degree lost its sensibility, or more correctly its impressibility, and often when the cophosis is suspected or detected, it is frequently attributed to the mental incapacity which accompanies it, but which is often its consequence, so that the examination of the organ is too long delayed for the useful application of remedies. The difficulty, and in the infant the impossibility, of discovering the malformation of the tympanum, places surgery at the greatest disadvantage; and when a non-impressible condition of the nerve, or a malformation of the labyrinth co-exists, it becomes quite impossible to ascertain any unnatural structure, which is not evidenced to the Surgeon's sight or touch; this circumstance is, however, of the less importance, as the case is beyond the reach of remedial art. When, however, as in the case

related by Sir A. Cooper, the labyrinth, with its nerve is properly constructed and performing its healthy function, and the patient of an age capable of comprehension, and with hearing and speech sufficient to receive and to communicate the ideas necessary to the inquiry, a correct diagnosis may frequently be formed.

An examination by the meatus will teach the condition of the membrana tympani; and if it be ossified, although the internal Ear may receive the impression communicated by the bones of the head, and transmit it to the brain; yet, the Dysecœa will be incurable, unless indeed, having assured himself of the perfection of the Eustachian tube, and hoping that the tympanic cavity is well formed, the Surgeon shall be bold enough to break away the ossified membrane, separating with it of course the malleus, and in all probability also the incus, and trusting that the stapes may remain *in situ*. Should such an operation be thus happily performed, and the consequent inflammation moderate, it is possible that an useful increase of hearing might be obtained. But the safe perforation of the osseous structure would be nearly impracticable, and the danger of destructive inflammation so great as to render the operation inadvisable. No Surgeon would feel himself justified in entertaining a momentary idea of such a proceeding, if one Ear were normal, and performing its functions correctly.

The natural state of the membrane, and the performance by the labyrinth of its function, will lead the surgeon to examine the Eustachian tube; and if air be not admitted to the tympanum during a forcible expiration with the noise and mouth closed, and upon the most careful sounding he finds the canal imperforate, he may in some rare cases overcome the obstruction in a manner to be noticed further on; or, if he should discover that it is closed against all dilatation, Sir A. Cooper's operation is the only resource, and the sooner after the true state of the part is ascertained, the membrana tympani is punctured, the more probable will be a beneficial result. The impossibility of correctly ascertaining the condition of the Eustachian tube without direct exploration, must be manifest, and this is more particularly to be observed

in cases of deaf-dumbness. The Author has lately catheterized the tubes of a deaf-dumb young woman, and found them normal, readily admitting the injection of air into the tympani; yet during her childhood, one of the most scientific and justly celebrated surgeons pronounced her deafness to arise from an obliterated state of these canals.

The presence of caseous or scrofulous matter in the tympanum, may be suspected, when, in addition to the action of the internal Ear, and the healthy state of the membrane, the Eustachian tube readily admits a sound or catheter, but does not transmit air; and a stylette or catgut sound introduced into the cavity, is besmeared with a whitish material. In such a case, the attempt, frequently repeated, to wash out the cavity with bland fluids, injected through the Eustachian tube, might be attended with success, provided the abnormal deposit is confined to the tympanum.

The unnatural enlargement or diminution in the size of the cavity, and the variation in the structure or number of the ossicula, will be altogether irremediable.

The Labyrinth, which is developed earlier than the tympanum, and quite independently of that cavity, presents circumstances of considerable interest in its formation. The membranous canals are formed some time prior to the osseous: even at the third month, according to J. F. Meckel, they are completely developed, surrounded by a structure entirely cartilaginous, and which is destined afterwards to become ossified. The membranes are at first double, one contained within the other, but without any continuity; and together they are thicker and more resisting than at subsequent periods. The internal membrane is whitish, transparent, thinner, but stronger and more elastic than the external; which latter does not appear to be attached to the cartilage, though eventually it adheres to the bone which is developed in the cartilage. The external membrane — the inner face of which is smooth, and the outer roughish,— gradually becomes thinner, and having secreted the bony walls, at last disappears, so that at the seventh month no trace of it is left. The internal becomes in proportion narrower

and stronger, and soon after its formation is attached to the surrounding cartilage, from which it subsequently separates to constitute the membranous labyrinth. Meckel has not been able to ascertain, if at any early period of formation the membranous labyrinth is unconnected and loose in the cavity of the cranium; or whether its structure is more simple than it is seen at the third month, when it is surrounded by a cartilaginous mass, and is as complicated as at more advanced periods. He has remarked that, like the enveloping cartilage, it projects at first more inwards, and is more elevated, than afterwards, which depends upon the increasing size of the brain. Valentin however describes the labyrinth, in its earliest periods, as a simple longitudinal sac, being somewhat uneven on its interior; which may be considered as the rudimentary vestibule; and that this is so completely insulated from the surrounding textures, that it may be readily drawn out, and that too when the cochlea and semicircular canals are somewhat advanced in their formation. Even previously to this period, Huschke and Valentin have recognised the sac, afterwards to become the labyrinth, presenting the appearance of a little gland; they unhesitatingly affirm that the sacs of the right and left ears, previously to the origin of the nerves, communicate together.

At the fourth month, the membranous cochlea is as complicated as in the adult, while even later, it is surrounded only by a thick membrane, which forms a part of the common membranous labyrinth. Meckel, who has so accurately investigated the developmental anatomy of the Ear, has not ascertained what form the cochlea presents previously to the fourth month of fœtal life; it however appears, from the investigations of others, that it at first assumes the shape of a little sac prolonged from the vestibule, which is partially divided by a straight septum, resembling very nearly the simple cochlea of the bird and of the reptile. The investigations of Valentin lead him to describe the commencement of the development of the cochlea as preceding that of the semicircular canals. The latter are elongations of the vestibular sac,

and he has ascertained that the posterior is first formed, then the superior, and lastly, the external. It is interesting to notice the very large calibre of the canals at their early period; they become gradually contracted as their development proceeds, leaving only their ampullæ of the original size. The fenestra rotunda and its membrane are, at their commencement, placed more externally and parallel to the membrane of the tympanum; assuming their permanent position as the bone is deposited.

The bony labyrinth is formed independently of the petrous portion of the temporal bone, which is ossified in the usual way, through the medium of cartilage; the circumference of the fenestra rotunda is first formed, about the third month, which is somewhat remarkable, as it thus corresponds to the outer margin of the tympanum. At the same period, an osseous point, altogether distinct from the petrous bone, commences at the external margin of the vertical canal; and another in the centre of the posterior canal: these nuclei extend to form the canals, and likewise downwards to construct the floor of the labyrinth. The superior canal, according to Meckel, but from which opinion Valentin differs, is the first completed, when from its inner surface the ossification extending, surrounds the meatus auditorius internus, internal to the portio petrosa; it also now forms the base of the cochlea. The horizontal semicircular canal begins its ossification not till the fifth month, when the bony deposit extends from the vertical, downwards, outwards, and backwards, around its membrane. The interior of the cochlea is formed entirely from the osseous labyrinth; the petrous portion only occupping the narrow external interstices between the spires. The ossification of the cochlea commences from the upper edge of the fenestra rotunda, and extends, upon the external surface, to the apex, then crossing its centre, so as to form an incomplete division into an internal and external cavity. The outer surface of the cochlea is at this time smooth, and like the membranous portion it also bears a considerable resemblance to the similar structure in the bird and reptile. As the cochlea enlarges from without inwards, this septum

becomes narrower, and little projections are formed upon it, eventually to constitute the spiral division.

In the early period, the osseous labyrinth is quite separated from the petrous portion by which it is surrounded; the outer surface of the labyrinth being smooth, while the opposed bone is roughish; they are soon united together, yet even in infancy, the line of demarcation may be distinguished, and the petrous bone be neatly removed, leaving the surface of the labyrinth polished; in the course of some months they become inseparable. This line of demarcation, though perfect throughout the labyrinth, is best marked over the cochlea.

As the osseous labyrinth is formed independently of the petrous bone, an excellent opportunity of dissecting the internal Ear is afforded, previously to their union; and as the external of the two membranes disappears, as the ossification is progressing, it is more than probable, that having secreted the bone by its outer surface, it is lost as a distinct membrane, by becoming the internal lining of the osseous labyrinth. Probably the same membrane previously forms the membranous canals. Thus, then, the formation of the labyrinth nearly corresponds to that of the teeth. Ribes has described the perilymph as being reddish, and as exactly filling the canals, during the fœtal period; whilst during the earliest childhood it becomes clear and limpid, and its quantity lessened in proportion as the Ear becomes sensible to sound. Valentin on the contrary declares, that the fluid is clear and transparent, from its first formation. The two fluids are secreted by the respective membranes which contain them.

Although the deafness which arises in consequence of malformation of the labyrinth is irremediable, and with our present extent of knowledge the variations in formation can only be guessed at; yet so pitiable is the insulated condition of the deaf and dumb, that it becomes the surgeon's duty to chronicle the abnormal constructions which have occasionally been discovered, as a possibility may exist, that hereafter the precise malformation may be once in many instances ascertained, and perhaps to a degree remedied.

1. Rœderer and Meckel have described a development

of the labyrinth so imperfect, that one single cavity only existed, — undivided into vestibule, semicircular canals, and cochlea, and closed at its outer border so as not to communicate with the tympanum. Such a form bears an analogy to the simple Ear of the crustacea, and may perhaps be the normal condition at some very early period in the human fœtus.

2. The Cochlea has resembled that of some lower animals, by forming only one turn and a half, as detected by Mondini, and it has been seen to form merely a cul-de-sac, without any spiral, corresponding to the temporary condition in the fœtus, and to the permanent state in birds and reptiles. Since the cases mentioned below were published, Mr. Cock, in the further dissections of children who have died in the Asylum for the Deaf and Dumb, has met with several cases of malformed cochleæ; in one a simple cul-de-sac was formed, communicating very largely with the vestibule, resembling a conical distension of that cavity; in another the cochlea was altogether deficient, its situation being occupied by bone so dense and hard as to resist the saw. In two there were slight attempts to form the spiral septa and the axes, these portions being quite rudimentary. In one of these instances the semicircular canals were also imperfect. Mr. Cock has published a detailed account of these interesting dissections, in the seventh number of Guy's Hospital Reports, which is accompanied by diagrams illustrative of the malformations, for copies of which see Plate XII., figs, 13, 14, 15. These imperfect developments of the cochlea have been supposed to be the causes of cophosis, inasmuch as they were met with in the deaf, but if the other parts of the Ear were healthy, it is difficult to understand how these defects alone could give rise to such an extensive effect.

3. Mondini has also related an instance of an imperfect ossification of the bony labyrinth, in consequence of which the membranous labyrinth was partly exposed.

4. In a very interesting paper in the nineteenth volume of the Medico-Chirurgical Transactions, Mr. Cock has described, and illustrated by diagrams, two examples of partial deficiency of the semicircular canals. "The

Plate 12.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 13.

Fig. 14.

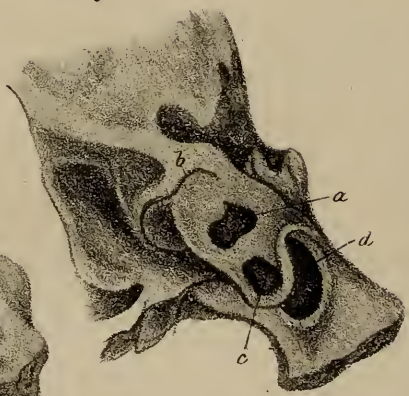
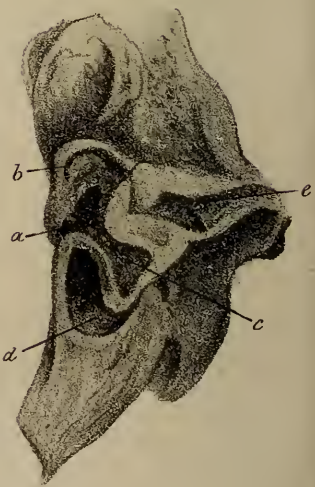


Fig. 15.



extremities of these tubes, opening into the vestibule, were perfect, but the central portions were impervious,

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PLATE XII.

Fig. 1. — Membrana Tympani of Mr. G., of which only that part which is of a lighter colour remains.
Fig. 2. — The Membrane lacerated by a blow.
Fig. 3. — The Membrane lacerated in the attempt to extract a pin.
Fig. 4. — The Membrane of a Medical Man, having a fungus projecting through it; — in this ear he is considerably deaf.
Fig. 5. — The other Membrane of the same gentleman.
Fig. 6. — One of the Membranes of Mr. P., whose case first suggested the idea of puncturing the Membrane.
Fig. 7. — The appearance of the Membrane after the operation of puncturing.

The above are copied from Sir A. Cooper's Plate in the Philosophical Transactions.

Fig. 8. — Represents the Membrane of Miss J. R.'s left ear.
Fig. 9. — The appearance of Miss M.'s ear, the Membrane being removed, — the Incus is plainly seen, with the Stapes in outline, the Malleus being lost.
Fig. 10. — Represents the malformed semicircular canals of the first case, and right ear of the second case described by Mr. Cock.
Fig. 11. — The canals of the left ear in Mr. Cock's second case. The dotted lines denote the defective portions.
Fig. 12. — Represents Mr. Thurnam's case of imperfect horizontal canal in the right ear.
Fig. 13. — Malformed Cochlea, the Canals being deficient. a. The Vestibule; b. The Cochlea; c. The commencement of the Fallopian canal, laid open by the Section.
Fig. 14. — Malformed Cochlea and Canals. a. Vestibule; b. Abnormal continuity between the vertical and oblique semicircular Canals; c. Meatus auditorius internus; d. Irregular cavity representing the Cochlea, with a rudimentary lamina spiralis.
Fig. 15. — Malformed Cochlea and Aqueduct. a. Vestibule; b. Vertical semicircular Canal; c. Meatus auditorius internus; d. Irregular cavity representing the Cochlea; e. Aquæductus Vestibuli, preternaturally large.

or rather did not exist at all. In the first case he had an opportunity of examining the Ear of one side only. The vertical and oblique semicircular canals were both impervious at their central points. In the second case both Ears were examined. On the right side, the middle portions of the oblique and vertical canals were wanting, the bone presenting the appearance of the first case. On the left side, the horizontal and vertical canals exhibited a similar imperfection. The scala tympani likewise was terminated, at its larger extremity, by a bony septum, which separated it from the tympanum, and occupied the situation of the membrane of the fenestra rotunda." (Plate XII., figs. 10, 11.)

The same volume contains the account by Mr. Thurnam, of a dissection of a boy, aged thirteen years, congenitally deaf; the horizontal semicircular canal was imperfect on the right side, in about the outer third of its extent; but what, perhaps, might be regarded as an abortive attempt at its formation existed (Plate XII., fig. 12). He did not discover any trace of sacculus or utriculus vestibuli, nor of membranous semicircular canals.

In the left Ear the osseous canals were perfect, but the membranous were very minute and gelatiniform, and there was no sacculus in the vestibule.

5. Closure of the fenestra rotunda by ossification, must be considered as a most important malformation; and if the views taken of the physiology of hearing in an earlier part of this essay be correct, such an irregularity of construction must, by preventing the undulations of the fluid, prove an invincible barrier to the function. It is unfortunate that in the second case quoted above from Mr. Cock, it is not stated to what degree the child was deaf; and if it heard at all, whether the function was confined to the right Ear; as we should be led to infer that some impression might be made upon the nerve through the one perfect canal, cochlea and vestibule, where the membrane of the round opening was perfect, and that cophosis would be complete in the left organ the fenestra rotunda being closed by bone.

Mr. Cock has had another opportunity furnished by

the same charity, of ascertaining the cause of congenital deafness; in the case of this child "not a vestige was to be found of the fenestra rotunda on either side, the usual situation of the membrane being occupied by solid bone." "The temporal bones were exceeedingly large, though soft and spongy in texture. The cavities were more than usually capacious, and the Eustachian tubes presented a remarkable development, being three or four times larger than common. On one side, the aqueduct of the vestibule readily allowed the passage of a large bristle; on the other side, the canal could not be traced through the bone, although its two extremities were more than usually expanded."

Ribes has described a similar malformation of the fenestra rotunda.

6. As by some physiologists the aqueducts of Cotunnus are esteemed appendages to the labyrinth essential to hearing, the abnormal enlargement of that of the vestibule may here be alluded to as a malformation, although it may admit of a doubt if such a variation can produce an important defect of function. Allusion has been made to its imperfection in a case above noticed. Mr. Dalrymple is quoted by Mr. Cock, to have ascertained by dissection of a case of congenital deafness, that "the Aquæductus Vestibuli was so large as to admit the passage of a small probe, whereas, in the natural state, a fine hair can with difficulty be introduced into the canal." He imagines this defect to become a cause of deafness, by allowing the fluid to recede so readily from the vestibule, that its undulations will not extend to the canals and cochlea.

7. Several cases are recorded of an alteration in the contents of the membranous labyrinth. Sir A. Cooper, in the Philosophical Transactions, relates a case dissected by Mr. Cline, of a young man who had been deaf and dumb from birth, in which "all the parts were healthy and perfect, except the vestibule, cochlea, and semicircular canals, and these were filled with a substance of the consistence of cheese, instead of the fluid usually contained." Dr. Haighton met with a case in which the

vestibule was filled with caseous matter. Mr. Thurnam, and Mr. Cock coincides in the opinion, thinks it possible that these cases may have been deceptive, as the bone dust, produced by the saw, combining with the water of the labyrinth, presents a similar appearance : it can, however, hardly be conceived that such acute observers of nature would run into this error; and as such a deposit undoubtedly has been found in the tympanum, as a congenital defect, and as the effect produced was that which would be expected, it is much more probable that the variation existed as an original formation. Itard has described a calcareous body in the vestibule, as a maldeposit producing deafness. It is possible that this appearance may be the otolithe of Breschet, although we have doubted its existence in the human Ear. If it should occur as a malformation, it affords another example of the occasional approximation in peculiar structures of man to those of the lower animals. A deficiency in the aqua labyrinthi, leaving a dry and empty state of the canals, has been noticed by Pinel as a cause of loss of function. Such a deficiency of secretion, it appears, is not an uncommon cause of senile cophosis, though probably not often occurring as a congenital condition. Over accumulation of fluid is also named as a probable preventive of its undulations.

8. In this general enumeration of the different deviations from the normal formation, it is necessary to allude to the absence of the utriculus vestibuli, as noticed by Mr. Thurnam in the above case, though he does not state whether the fluid was likewise deficient, or whether it was contained in the vestibule in contact with the lining membrane of the bone, constituting a part of the perilymph. An absence of the fluid must be completely detrimental to the function of hearing; but it may be questioned to what extent cophosis would be produced by the want of the membranous sac alone.

9. Lastly, the total absence of the labyrinth; — to such a deficiency Meckel has alluded as having been seen by Rœderer, accompanied by an absence of the rest of the organ; in fact, the whole ear was wanting. The instance

seen by Mr. S. Cooper could not have been an example of this most rare deficiency in development, as the child is reported to have heard tolerably well.

Probably the most frequent cause of congenital deafness is seated in the acoustic nerve, in some part of its course, origin, or distribution, or perhaps in its entire structure. The lost of audition has been generally attributed to some derangement in structure or inaction of the nerve; and as upon very careful dissection no variation is often to be found corresponding to the loss of function, pathologists may be excused for attributing it to a faulty nerve, though in appearance it may be normal. The nerve, however, has presented vitiations in development: Haighton, Sylvius, Hoffman, and others have met with it less than half its customary size: Itard has seen examples of such diminution, which he, however, considers rather as a consequence, than as the cause of the deafness. The nerve has also been found harder than natural, even more firm than the accompanying facial; this deviation was noticed by Rosenthal. It has been rendered non-impressible or insensible by compression from a steatoma. Likewise it has been found completely disorganized, the neurilema holding in its interstices a little fluid only; such derangement is perhaps more frequently the result of long continued inactivity of the nerve, (as is frequently seen in the case of the optic nerve, in consequence of blindness,) than the cause of the deafness.

In a treatise on the Ear it would be misplaced to describe the malformations or deficiencies in the development of the brain, which must produce dysecœa, conjoined with a partial, or complete loss of the other functions of sense.

The majority of instances in which the organs of hearing of the deaf and dumb have been examined, have not presented vitiations of form which would account for the loss of function. Of the five cases published by Mr. Cock, although they all furnished evident and well marked traces of scrofulous disease, yet two only presented malformations, which that excellent anatomist could consider as cognate, and as the cause of the deafness. Although the cause of congenital cophosis may remain concealed,

it is unphilosophical to declare, with some aurists, that the affection does not result from defective formation, and that therefore it is fruitless ever to attempt its investigation with the view of applying remedies; it is now well understood that there exist minute changes in the anatomical arrangement of particles which the investigator has not as yet the means of unfolding, but which may yet be incompatible with the performance of the function of the organ: this observation being peculiarly applicable to the nervous system, it may occur that some deficiency may exist in the tympanic plexus of nerves, sufficient to interfere with the mechanical operations of the organ, — or in the sensory nerve, capable of preventing its vital functions, — both of which may elude the most careful searching. Nevertheless, besides the great difficulty, nay impossibility, of fixing the seat of malformation, when it is out of view, or beyond exploration, it must be recollected that as the imperfection of audition is often occasioned by a cause not to be detected even when the organ is laid open to our sight, so it may be expected that the greater number of cases of deaf-dumbness will remain incurable.

As might be anticipated from what has preceded regarding the malformations, the degree of deafness varies. In few instances is it at first quite complete; but as the infant is incapable of the mental attention necessary to catch the slight influence conveyed to its immature mind, and as the sounds ordinarily falling upon its imperfect ear, are insufficient to produce an effect, the labyrinth, and the auditory nerve in particular, become less and less capable of being called into action; and thus in a short time, perhaps even before the defect is recognized, the function is diminished almost to entire deafness. It becomes, therefore, absolutely requisite that the very first indications of deficient audition should excite alarm, and consequently attention to its causes and treatment on the part of the parents and practitioner. If any remedy is applicable, it must be used very early: examples are not wanting in which the original defect has been removed from the external ear or the tympanum, but the sense of hearing has been but partially restored, and that with difficulty, in consequence of the long state of inactivity of

the nerve; and perhaps also of the portion of brain from which the nerve proceeds.

The Author has lately witnessed an interesting example of this fact, in a *sourd-muet* eighteen years old, in whom the function is gradually improving, under the judicious use of the organ, although the malformation being seated in the labyrinth is irremovable: in this instance the sense is not quite so defective on one side as on the other, which catheterism of the Eustachian tubes proved to depend upon the normal condition of one and the contracted state of the other canal.

Writers on acoustic surgery, and particularly Rosenthal and Itard, have arranged the degrees of deafness. The former author has adopted three divisions: — 1. Surditas, cophosis, or deafness, in which the faculty of hearing articulated sounds is completely annihilated. — 2. Dysecœa, difficulty of hearing, in which the function is so diminished that articulated sounds cannot be heard without the aid of an apparatus. — 3. Paracousis, alteration, or diminution of hearing, in which audition is imperfect for want of precision.

Under these heads are included, not only the imperfections arising from congenital defects, but also those produced by acquired disease; and the different terms are often used synonymously to indicate defective hearing.

The various degrees of deafness will throw but little light upon the malformations producing them, — as they will be materially influenced by the mental and corporeal condition of the child, and by the circumstances intellectual and physical which surround it; thus the idiot with a perfect organ of sense is deaf to an extent depending upon his mental incapacity. It is quite possible that some cases of deficient structure, which may be occasioned by innate want of productive power, may be saved from the unfortunate combination of strumous deposit or disease, by an early treatment of the strumous diathesis; and it is worthy of remark that most children, who are affected with this sad deprivation, are of the scrofulous habit. Again, in instances where the sense of hearing is possessed to a limited extent only, that extent may be increased by an early, assiduous, and careful use of the

organ. Much may, therefore, be occasionally accomplished, by affectionate assiduity on the part of the parent, and intelligent direction on that of the practitioner.

The cases in which it has been supposed that the deaf-dumb have been taught to speak, are probably of this description; inarticulate sounds have been heard; and in his endeavour to repeat them, the deaf mute has been taught, through the medium of his acute sense of touch, but particularly of sight, so to influence his organs of voice and of speech as to produce an articulation; the examples of the vowels being uttered in this manner are numerous. But as his own simple articulations are no more communicated to his sensorium, than are the more complex ones of his teacher, — as he can cannot comprehend the thought intended to be conveyed by the unheard articulation, — and as he cannot clothe his own ideas in articulate language, but merely utter sounds, such as may be produced by Wheatstone's tubes, — the deaf-dumb cannot be said ever yet to have been taught to speak; the criticism, therefore, of Kramer upon the instances related by Deleau and Itard, though severe, may be considered as just.

Mankind cannot be too grateful for the zealous and successful exertions of those humane philosophers, who have, to a very great extent, succeeded in teaching the deaf mute a language of signs, by which he can hold rapid communication with his fellow man; which, added to the facility with which he may be taught to read and write, goes far to remove him from the deplorable state of insulation, which his defect must otherwise entail; and to place a condition of usefulness and independence within his reach.

It is a curious circumstance that deaf-dumbness is much more frequent in males than in females, which is in violation of the ordinary law, that as the power of formation is weaker in the female fœtus than in the male, so are the deficiencies more frequent. Mr. May, the Director of the Deaf and Dumb School, at Vienna, stated that the proportion of deaf boys to girls was as four to one.

Congenital deafness does not appear to be hereditary, as most of the parents of deaf children have had no defect of their organs; and it is a rare circumstance to meet a case of a deaf child who was the fruit of parents, either one or both similarly affected. On the other hand, several children of one family will be thus defective, without any known cause, while the others will be perfectly healthy. Kramer relates the singular instance of "a man and his wife, of the name of Hartness, both of them healthy, and having no hereditary predisposition to any disease of the Ear in their family on either side, who have five daughters and six sons; the latter were all born deaf-dumb, whilst the daughters, without exception, heard perfectly well. The mother of these eleven children is not aware of any circumstance that distinguished her pregnancies from each other, though the children are so remarkably differently endowed. She was always healthy and active. One of their children has married a deaf-dumb girl, but their marriage has been childless." A healthy couple, residing in the parish of Bishopsgate, with a large family, have two of their daughters deaf and dumb; the eldest, about forty years of age, has married a *sourd-muet*, and become the mother of several children, all of whom enjoy perfect audition; the youngest, aged twenty-six, can hear a few sounds, and indistinctly utter a few words, which, however, appear to be simply vocalized. The roof of her mouth is very concave; the right membrana tympani is abnormally oblique and very transparent, the left is opaque, but natural in shape and size,—the Eustachian tubes are healthy,—it is probable that the diameter of the right tympanum is smaller than usual, and that malformation exists in both labyrinths.

PART III.

ON THE DISEASES OF THE EAR.

In its pathology the Ear does not differ from other structures. From this general conclusion, perhaps, may be excepted inspissation of wax in the meatus, the exact analogue of that secretion not being elsewhere met with. Inflammation, therefore, is the affection to which, for the most part, this organ is obnoxious; and as this disease is modified in its progress, in its symptoms, and in its effects, by the structures which it attacks,—by the local predisposition of the organ affected, by the general constitution of the individual,—by the causes which may excite it,—by the external circumstances, or conditions which accompany it,—so have the affections of the Ear been arranged under various heads, nearly all of which may be reduced to inflammation and its consequences. As in all other organs, of which the seat of function is in an expanded nerve, the Ear is likewise subject to an anæsthetic affection, dependent on some hidden morbid condition, and occasionally on inflammation, either of the acoustic nerve, or of those parts of the brain in connection with the organ. Again, in consequence of the vicinity of the Ear to the brain, it often participates in the diseases and accidents of that organ; and the reverse is frequently observed of disease extending from the Ear to the brain or the skull. Lastly, the accidental introduction of foreign bodies into the meatus; the rupture by a blow or otherwise of the membrana tympani, have been esteemed peculiar to the Ear; but perhaps hardly with justice, as nearly similar accidents are met with in the nasal and visual organs.

It is purposed first to treat of inflammation of the Ear

in general; secondly, of its effects upon the different divisions of the organ, with observations upon the accidents and operations to which each division may be subjected; and lastly, of the nervous affections, which are supposed to be independent of inflammation.

CHAPTER I.

OTITIS.

Until within a few years, the facts connected with the Ear were so scattered, and the conclusions deduced so vague, the diseases were so little understood and so mal-arranged, that the term otitis was hardly employed. *Otalgia*, or *Ear-ache*, was more frequently used, that symptom being very evident, though the cause remained concealed.

Otitis, which term should imply the general disease of the whole organ, is arranged under the two heads *Acute* and *Chronic;* the latter form or degree of inflammation frequently being termed *Otorrhœa*, in consequence of the discharge of matter from the meatus, which often accompanies it. Inflammation may either be *External* or *Internal;* the former including the affection of the auricle and meatus auditorius; the latter that of the tympanum and labyrinth. In treating Otitis Interna, authors have more particularly described inflammation of the tympanum and its consequences: as from its structure and situation, the labyrinth when inflamed does not present those direct evidences which are recognised in the Middle Ear.

Section I.

Acute Otitis, *Otalgia*, or *Ear-ache*, does not frequently attack the entire organ at the same time, nor from the same cause; but generally commencing in either the

external Ear, or the tympanum, it extends to the rest of the apparatus; thus, if the cause be applied, as often is the case, to the auricle or the meatus, the inflammation in its progress may reach the membrane and the cavity of the tympanum, and pass on to its appendages, and even to the labyrinth; if on the other hand the inflammation be excited in the tympanum, immediately, or through the medium of the Eustachian tube, it may spread inwards to the labyrinth, and outwards to the meatus. This circumstance evidently arises from the different degrees of exposure to the exciting causes to which the outer and inner divisions of the Ear are liable: but it is very possible that the same sudden variation of temperature may inflame at the same time the external meatus, and the lining membrane of the tympanum, and thus that general Otitis shall arise, but this is comparatively an unusual occurrence.

The Causes of Otitis are similar to those producing phlegmasia in other organs, modified in their frequency by the predispositions of the structures. Among the most common may be enumerated cold, and especially if suddenly applied to the Ear, when its temperature is unnaturally raised; this exciting cause directly affects the auricle, and particularly the meatus, and indirectly the tympanum, through the Eustachian tube, — a foreign body irritating the auditory canal; and wax inspissated to extreme hardness may be considered as a foreign irritant, — wounds of various kinds, sometimes lacerating, or cutting the membrane, — the extension of inflammation from the surrounding parts, particularly of Erysipelas from the scalp, of Scarlatina, of Variola, of Rubeola, &c. to the outer Ear; of Tonsillitis, or Syphilis, or any affection of the fauces to the Eustachian tube, and onwards to the tympanum, — of disease of the brain, or its membranes to the labyrinth, — likewise irritating injections administered to the auditory canal. Galvanism and Electricity have been enumerated as exciting causes, when too freely used for the removal of deafness. Inflammation is described also to have arisen from metastasis in consequence of the sudden removal of ophthalmia, or of gonorrhœa; likewise to have been excited by a carious tooth. Otitis

occasionally arises during the progress, or towards the termination of general acute disease, as continued or typhoid fevers. The disease is occasionally seen to pass to the Ear from the neighbouring parts, and back again, forming an alternating vicarious affection; it also alternates in children with cutaneous eruptions, and especially during dentition. Individuals of the scrofulous diathesis, of the syphilitic taint, or having irritable mucous membranes, and those who are the subjects of cutaneous eruptions, are particularly predisposed to Otitis; but this predisposition is most remarkable in strumous children. The symptoms and consequences of Otitis vary according to the structure of the part inflamed, and as these variations are very great, authors are obliged, for the sake of perspicuity, to describe separately the diseases as they are locally situated; and hence the division of inflammation of the Ear into external and internal, is not only justifiable but very useful.

Section II.

Otitis Externa. — Acute inflammation may commence simultaneously in the auricle and meatus, the same cause affecting both parts at the same time, or it may be confined to either portion; but more frequently it extends from the one to the other, and generally from the auricle to the canal; yet the limitation of the disease to the meatus is a very common occurrence.

Any cause of inflammation being applied will excite the auricle into disease; but it is more frequently affected with erysipelas, than with any other form of acute disorder. This part is peculiarized by the great readiness with which it becomes tumefied, and in erysipelas by the large size of the vesications which are formed upon it; which circumstances are consequent upon the perfect organization of the skin and subcutaneous cellular tissue.

In the first instance there is rather a sense of heat than actual pain; but afterwards there is a burning and painful sensation, which soon becomes almost intolerable; of

course the redness is excessive, the skin being naturally so very well supplied with blood. From these circumstances it arises, that one of the most distressing concomitants of erysipelas is the impossibility of the patient changing his posture from his back, to lie upon his side, in consequence of the unbearable pressure upon the Ear. The tumefaction of the concha is often so great as to completely close the opening of the meatus, by which nearly complete deafness is occasioned, even when the inflammation does not, as it generally does, extend into the canal. The disease often leaves the part thickened and hardened, by adhesive matter effused into the cellular membrane, or sometimes by a positive deposition in the fibro-cartilage. In the majority of cases the auricle is restored in time to its normal condition by the process of absorption, but occasionally the part continues ever afterwards indurated. An abscess is sometimes produced, which endangers an ulceration of the cartilage, and occasionally ulceration, to which the structure of the auricle is predisposed, even takes place without the formation of matter; an opening is thus sometimes formed through the cartilage, which is exceedingly likely to become permanent. Sloughing of the cartilage is also now and then a termination of its inflammation; this effect is most common when the Ear has been frost-bitten, under which circumstance, the vital powers have been much reduced by the extreme cold, and are, therefore, incapable of bearing the consequent violent reaction.

The auricle is also the subject of erythema, of small-pox, of measles, in short of all the inflammatory actions, either common or peculiar, which affect the cutaneous system; these different diseases pass through their ordinary stages, and produce their usual effects, with modifications arising from the predisposition occasioned by the structure above alluded to.

The *treatment* must be conducted upon general principles; when the inflammation is peculiar, the object of the surgeon will be so far to lessen its severity, during the necessary progress, as to diminish the probability of the affection extending to the meatus; this desirable object, however, is often not to be obtained, and in many

cases the patient must feel grateful if the spreading of the disease has been confined to the canal. With the above view bloodletting from numerous punctures made by a lancet, is attended with much advantage in erysipelas. When the inflammation is excited by common causes, antiphlogistic means actively employed, will frequently be successful, not only in limiting its seat, but also in confining its termination to effusion of serum, which will in most instances become easily absorbed. Induration, suppuration, or sloughing, will require the same treatment as when taking place in other parts of the body; but as the cartilage lost by disease is rarely reproduced, it becomes the more important to diminish the extent of the acute stage. When applying stimulants to an unhealthy ulcer, or to a sloughing state of the auricle, the surgeon should be careful that the excitement be not carried to too great an amount, lest the meatus may be also unduly influenced.

Inflammation of the External Auditory Canal is usually ushered in by an uneasiness in the tube, as though a foreign body were there producing rather titillation than pain, and the patient frequently introduces his finger to remove the supposed irritant, but the contact of the finger, and distension of the canal exciting considerable pain, he immediately desists. The uneasiness soon augments into an itching sensation; and in a little while is followed by pain, at first slight, then gradually, but with varying rapidity, increased in intensity, sometimes to an amount almost intolerable, and even, in the severer cases, producing delirium and distressing exclamations from the very agony. When the pain is so very great, it is more than probable, that Otalgia, properly so called, or Ear-ache, is excited in the tympanum, which may undoubtedly occur without inflammation, and which nervous excitement often precedes that of the vascular system. The pain, in severe cases, is often lancinating, described as shooting through the head and face, and down the neck, attended by a burning sensation, and feeling of distension in the tube. Audition is always diminished, and entirely suspended, when the inflammation is intense; yet, frequently, there is a whistling or humming noise, still further increasing the annoyance of the patient. The pain

is augmented by pressure, — by moving the auricle in order to examine the canal, — by the motions of the jaw in mastication, and even in speaking, — and by the contact of cold air, or of too great heat, though relief is afforded by a temperature moderately raised.

Upon examination of the auditory canal at the very commencement of the uneasiness, the lining membrane is found dry, and it may present a slight blush of red; soon afterwards, as the pain increases, the membrane of the canal becomes swollen and red, and often spongy, which changes ensue with great facility in consequence of the vascularity of its structure; from this cause alone the tube may even for a time be obliterated. When the inflammation has existed for a time, varying from a few hours to a day or more, the lining membrane is generally more or less covered with minute pustules or vesications, which are at first red, and if filled with serum become transparent; or if with pus, as in the higher degrees of inflammation, they assume a whitish colour. Sometimes these pustules are very small and numerous, at others they are larger and fewer in number, and they often occupy the whole length of the canal. Occasionally the serum is absorbed, but much more frequently the pustules or vesicles burst and the fluid escapes, giving rise to a discharge from the meatus. The matter escaping is often muco-purulent, very fetid and abundant, and where the inflammation has been severe it is frequently tinged with blood. This morbid secretion, which for the most part is the product of the ceruminous glands, may continue for a fortnight or three weeks, occasionally changing its degree of consistence, one day resembling pus and another mucus; at last it gradually thickens into a caseous matter, as the increased action subsides, and is followed by a copious formation of wax. Itard has named the latter form of the disease *External Catarrhal Otitis*, and that in which pus is formed in little pustules *External Purulent Otitis*.

The *Otitis Externa* much resembles inflammation of the other mucous membranes, the character of the matter secreted corresponding to the degree of inflammation; the slighter extent will fill the canal with mucus, — a greater amount with pus, — and it is frequently pustu-

lar; in infants, who are especially subject to this affection during dentition, the inflammation furnishes a membriform layer of inspissated fibrin, resembling that so often separated in acute affections of the other mucous membranes.

In Erysipelatous Otitis, the vesicles having burst, frequently degenerate into very troublesome ulcers, which continue to suppurate for a long time, accompanied with more or less deafness.

As comparatively a rare circumstance, an abscess is occasionally formed in the cellular tissue of the tube, in consequence of inflammation of the lining membrane; it occurs generally in the cartilaginous portion, and projecting into the canal frequently there discharges its pus by ulceration; it sometimes softens and ulcerates through the cartilage, forming an opening behind the meatus, where it is partly concealed by the lobus, and through which the matter escapes; this aperture occasionally becomes fistulous. As must have been noticed by every practitioner, an abscess is much more frequently formed in the cellular membrane surrounding the exterior of the canal, between it and the mastoid process, which becomes excessively painful from its confined position, — occasions cophosis by its pressure on the tube, and very often by ulceration discharges its pus into the meatus, which is the more easily effected in consequence of the natural divisions of the cartilage. The opening in the canal is usually readily seen, and gentle pressure behind the Ear will force the matter through it. Such an abscess, the Author has several times met with in children during their dentition, which without doubt is one of the causes of otorrhœa, properly so called. Yet if promptly treated the meatus may occasionally escape from being injured: a child who was teething was brought to the Author with a swelling behind and in the Ear, which presented an indistinct fluctuation, and by which great suffering was evidently occasioned; the meatus was completely closed. Poultices, &c., were applied, and on the following day the abscess was opened behind the canal, the pus was readily discharged, and the wound healing in a few days the tube gradually assumed its healthy dimen-

sions. A collection of matter has also occurred in front of the meatus, but more rarely, and Andral has seen pus, secreted in the parotid gland, find its exit through the auditory canal. The author is indebted to an intelligent friend for the following history of a case which points out the great destruction in which the Ear may be involved from surrounding disease.

"Mrs. B., æt. 43. — In April, 1838, was first attacked with acute pain in and about the right Ear, and the same side of the face and head, for which an unsound tooth was extracted, and afterwards a sound one was drawn, still without relief, though much of the pain appeared referrible to these teeth. Poultices and fomentations with medicines, sometimes tonic, as for tic doloureux, sometimes of other kinds were administered. She had during this first stage of the complaint occasional shiverings, and the hearing became very obtuse, — the pains were not constant, having exacerbation and remission, — the night, or the day also if she reclined, being much the worst, — the right eye began in two or three weeks to appear very weak, and the conjunctiva often became vascular, and the sight impaired; as she became worse I saw her and brought her to London. From the seat and character of the pain, the slight discharge from the Ear, the deafness, the shivering, the extreme heat over the Ear, mastoid cells, and at the upper part of the sterno-cleido-mastoid muscle extending forward to the angle of the jaw, I suspected abscess, but it was so deep, and in connection with such important parts that it could not be opened. This would again have been attempted, but that in a few hours a large gush of pure pus came from the Ear, and some time after their appeared to be a collection just below the mastoid process which I opened, matter escaped, and this I found had an imperfect connection with the meatus externus; temporary relief was always obtained by getting the matter from the Ear, which could be forced in no other way than by opening the jaw, which process, an exceedingly painful one, would as it were pump the matter out; often, however, the accumulation of matter prevented the opening of the jaw, — the Ear was kept syringed with warm

water and opium; poultices, and fomentations, were applied. Oftentimes I dropped into the meatus almond oil with morphine: when the sac of the abscess became inflamed, which occasionally happened, two or three leeches produced relief; aperients and some general means for giving tone to the system, were now with opiates the plan adopted; once or twice I saw small portions of grit which to me seemed like the ossicula of the Ear broken up. About two months from the commencement, the pain in the face (right side) became combined with numbness, the features, especially in smiling, were drawn to the left side, the muscles of the right side of the face, the orbicularis of the eye, &c., seemed to be losing their contractile power, — the eye became much weaker, — the sight being at one time nearly lost, which was benefitted by the application of two small blisters, — the right side of the tongue became quite benumbed, and the taste of food was imperfect, — pain was also felt in all the teeth on this side. It must be observed, that at all times the pain extended over no more than the right half of the head and face, the most excruciating agony being referred to the occiput and right temple, and sometimes to the ball of the eye. The action of the heart now often faltered, the pulse being quick and fluttering, which, however, would be relieved by a free discharge of matter from the Ear, — there was a vacant stare occasionally, which made me suspect the brain was becoming affected; she never, however, wavered in mind, nor was otherwise than most patients. In the worst period of the disease, the right tonsil and velum, as also I judge the Eustachian tube, being swollen, and inflamed, became much affected, in attempting to swallow more than a few drops; at such times the liquid would flow suddenly from the nose and mouth. It appeared to me that from partial paralysis, the velum often failed to act, so that it required constant care to keep what she took from passing back by the nose, and at such times there was violent coughing. When she put a watch between the teeth, she heard it somewhat better than when placed against the external Ear, but this was evidently fallacious, as one Ear was sound. At length a fungus formed in the external meatus, which

subsided upon my opening the abscess near the mastoid process; she had feverish irritation, but never anything like a fully developed fever. At one period of the disease she saw objects double, whether the sound eye was shut or open, evidently then with the diseased eye. A few days before her death, which was fourteen weeks from the commencement, paralysis though incomplete appeared in the upper extremities, the head and arms being affected with a palsied tremor, at length complete palsy and death resulted. Unfortunately there was no *post-mortem* examination, however, the symptoms clearly point out the material part of the case."

It appears that in this case an abscess originated in the cellular tissue between the meatus and parotid gland, which in its extension ulcerated into the auditory canal, reached the cavity of the tympanum, and eventually the brain, the pressure upon the nerves in the neighbourhood having interrupted their function.(*a*)

As consequences of such abscesses, when the ulcerations do not heal kindly, may be mentioned fistulous canals and openings, by which the morbid secretion is maintained, and fungoid granulations which encroaching upon the tube, increase the deafness. Acute external otitis frequently becomes chronic, which is to be considered further on.

A follicular abscess of one or more of the ceruminous glands is not an uncommon occurrence; the inflammation may be limited to the follicle diseased or extend along the canal, the amount of inconvenience depending upon the extent of inflammation and the size of the abscess,

(*a*) "We doubt this pathology," says the British and Foreign Review, vol. viii., "and think that if any one will read carefully the case he will come to the same conclusion as ourselves regarding it, viz., that it was an inflammation and abscess of the tympanum; that the abscess burst through the membrana tympani, and also pointed at the mastoid process; that the petrous bone and aqueduct of Fallopius, and, of course, the portio dura, became involved in the disease; and, lastly, that inflammation extended to the brain or its membranes."

which may completely, or only partially occupy the auditory tube.

Sometimes the general symptoms of external otitis, in cases of unusual severity are considerable, the febrile excitement running high; in cases of less urgency, the symptoms are nearly confined to the neighbourhood of the affected part.(*a*)

The *treatment* of inflammation of the external meatus is to be conducted upon the usual principles; if the local and the general symptoms are severe, and particularly if the individual be robust or plethoric, general bloodletting will be required, and sometimes even its repetition may be called for, although the majority of cases certainly are not sufficiently urgent to require this practice; yet, when there is a probability that the disease may extend inwards, the surgeon will not hesitate to attempt its limitation by bleeding and every other means in his power.

Leeches applied to the vicinity of the meatus, in numbers depending upon the amount of inflammation, will be quite requisite in the majority of instances, and their repetition usually several times required. The back part of the Ear and the mastoid process may be considered the most convenient position for their application, though they may be placed in front of the auricle, and generally about the angle of the jaw, particularly when a large number is employed. The experience of Itard leads him to believe that better effects are to be obtained from freely leeching the neighbourhood of the Ear, than from blood-letting. Brisk purgatives at first, and afterwards laxatives must be administered, as the most useful

(*a*) External otitis is not unfrequent in infants, in whom, often, its existence is not manifested very clearly. Disinclination to lie on the affected side, sudden cries and much agitation of the head may lead to suspicion, and to an examination of the ear. Redness of the part must not, however, be always expected. On the contrary, cases are met with in which the skin, made tenser by the resistance offered by the subjacent cartilage, is sometimes paler than natural. There will, however, be some tumefaction, and diminution, in consequence, of the size of the meatus; moderate pressure, or even slightly twitching the ear, will cause pain and elicit cries from the child.

derivatives. Blisters behind the Ears, in every affection, are so constantly in use, that the practice has become almost empirical; it is, however, certain that in the different forms of external Otitis, when the more violent symptoms have been reduced, or have naturally subsided, that the counter-irritation occasioned by a blister is often attended with marked advantage.

Of topical applications, the combination of warmth and moisture by affording the greatest relief to the patients' sufferings must be considered the best; thus fomentations over the whole Ear, and the temporal region, either medicated, as the decoction or infusion of poppy-heads, chamomiles, marsh-mallows, &c., or warm water alone, and covering the part with a warm moist poultice of linseed-meal or bread, will be particularly useful after the leeching. Itard recommends during the first stages, and before the discharge has come on, the introduction into the auditory meatus of a solution of five or six grains of opium in some emollient decoction, as a most important assuager of pain; but that this application, and all similar ones, are to be carefully avoided when the discharge has occurred; as the interruption to such abnormal secretion may be followed by a rapid increase of inflammation, and its extension to the deeper parts, — at such a period he instils warm milk, or some emollient decoction, as plantain, mallows, &c. Injections of every kind, even the mildest, have a doubtful effect in acute disease of the outer Ear; the mechanical injury produced by their introduction appears to be greater, than any advantage to be derived from them. Itard is in the habit of placing a soft piece of cotton, in which are enveloped about three grains of camphor, in the canal, with a view of affording relief. When the Otitis has subsided, or has become subacute, if the discharge continues, and does not appear, by its becoming daily thinner and less in quantity, to be subsiding, a very mild astringent lotion may be applied to the surface of the membrane, by being dropped into the tube, or upon a soft sponge; the irritation of injecting may be too great.

When an abscess has formed, and is projecting into the canal, relief will be expedited and the probable ex-

tent of ulceration lessened by the Surgeon puncturing it with a cataract needle or the Iris knife, as soon as he is quite satisfied of its existence, and that the projection is not occasioned by the tumefied membrane. In inflammation of the cellular tissue external to the meatus, resolution should be attempted by antiphlogistic means; but when suppuration has unfortunately occurred, the surgeon being anxious to prevent ulceration into the meatus, must open the abscess, in front of the mastoid process, behind or below the canal, as it may happen to point, as early as he can detect the presence of the fluid; and even when he only suspects its existence, if he has good reason to expect suppuration, he will be justified in making an incision with his lancet; and if he should fail in finding a collection, the cicatrix of the wound will eventually ulcerate more readily, and the pus more easily escape, that when the skin is in its normal condition. The propriety of this practice becomes more apparent when the surgeon recollects the serious evil which may attend the extension of the abscess into the meatus, and probable consequent danger to the membrana tympani.

Kramer has arranged the diseases of the external auditory passage under the heads of — 1st. Erysipelatous Inflammation; — 2dly. Inflammation of the Glandular Structure of the Meatus; — 3dly. Inflammation of the Cellular Tissue; — 4thly. Inflammation of the Periosteum. This division is useful to a certain extent, and every surgeon should bear in mind that each structure of the canal may be in certain cases the chief seat of inflammation; but that acute otitis is likely to continue exclusively in any one structure during its entire progress is more than doubtful. In most cases, perhaps, the disease commences in the glandular apparatus, but passes so rapidly to the cellular membrane, that the surgeon may not have had an opportunity of witnessing the affection in its original seat. Dr. Kramer does not appear to employ the term Erysipelatous with the meaning that is usually adopted in this country, and which has been used by the writer, but to imply thereby a morbid secretion of wax, depending upon an erythematic condition of the dermal membrane; as this state is rather chronic

than acute, or even sub-acute, it will be considered in another section of this treatise. His second division is the Catarrhal, to which allusion has already been made; in this section several other affections are described, some consequent upon the acute catarrh, and others independent of it, so that Kramer's somewhat severe criticism upon the mal-arrangement of other authors, may to a degree be applied to himself. The third division is the Phlegmonoid inflammation, which doubtless often occurs without involving the glandular structure, although that structure soon becomes implicated, unless the affection should be in the chronic form, and limited in extent, producing a very small abscess; such instances are far from uncommon; very often they are consequent upon the disease of the mucous membrane, and frequently occur in the chronic form. Kramer's fourth section, inflammation of the periosteum, is a chronic disease, and, in most cases, if not in all, is consequent upon previous inflammation in other structures.

It is interesting to remark the similarity of predisposition in structures formed at the same period of fœtal life, or of childhood; as two corresponding teeth on opposite sides of the jaw will become carious nearly at the same period in consequence of being alike affected during their formation: so it is often found that one ear being the subject of inflammation, the other, without evident cause, will become also attacked; and that sometimes the affections of these organs will alternate with each other. The fact is notorious, that persons deaf in one ear are very liable to disease in the other; which unfortunate predisposition is not solely to be referred to the circumstance of the sound ear being unusually exposed to the exciting causes, but in part, and perhaps mainly, to the same peculiarity occurring in both organs during their formation, which peculiarity will become permanent. Anatomists are in the habit of considering and describing as malformations those deviations only which are palpable; but pathology seems to teach us that malformations exist in the minute organization of different tissues, upon which may depend the various peculiarities and predispositions to disease. These observations are not appli-

cable to the external ear only, but may include all the structures of the entire organ; and this is doubtless the reason why diseases producing deafness are not often confined to one ear, unless the exciting cause be quite accidental.

Bearing upon this point, the following case may be mentioned:—The writer was consulted by a medical friend, in the winter of 1835-36. He had been deaf in the right ear for some years, in consequence of disease of the tympanum; he writes that "he was now suffering from an attack of inflammation near the external meatus of the left ear, which produced for a fortnight perfect deafness, by obstructing the passage, and not (as was thought by some), by implicating the tympanum. It ended in suppuration, the matter burst into the meatus, and he soon recovered." The Author saw him about a week or ten days after the commencement of the attack, when it was evident that pus was being formed in the cellular membrane, external to the cartilaginous portion of the canal; after the ulceration had taken place, by pressure of the finger behind the auricle upon the edge of the mastoid process, the matter readily escaped through the opening into the tube.

Allusion may be permitted to the following case, not as pointing to any peculiar circumstances, but as showing the ordinary progress of Otitis Externa arising from a specific cause:—Miss Janet R., about twelve years of age, had so severe an attack of scarlet fever, as seriously to endanger her life. The eruption extending along both *meatus auditorii externi* occasioned almost complete deafness; in a few days a copious discharge of yellowish-white matter, mixed with little flakes, took place. It soon assumed an exceedingly fetid odour, and continued, becoming more and more limpid and watery, during her convalescence, and several weeks after her perfect recovery. The flaky particles were doubtless exfoliations of the lining membrane. During the active stage the canals were simply washed out with warm water several times a day, with great relief to the little patient; upon the subsidence of the acute symptoms, weak solutions of the sulphate of zinc, alum, and nitrate of silver, were alter-

nately applied, and followed by a gradual lessening of the morbid secretion and restoration of hearing Upon examining his patient two months after the cessation of the fever, and one month after all remedies to the ears had been relinquished, the author found her afflicted with a slight degree of deafness; the healthy secretion of wax was nearly restored; the tympanic membrane of the left ear presented an ulcer at the lower and anterior part, occupying about one-third of its extent, and the malleus apparently still possessing its normal attachment (Plate XII., fig. 11). The membrane of the opposite ear was concealed by a small fungus, from which a muco-purulent secretion occurred. The hearing was more perfect on the left side than on the right.

The reports of cases of Otitis Externa might be multiplied, were further elucidation thought requisite, but unfortunately their occurrence is so common, that every practical surgeon must frequently witness them. The Author may add, that his experience teaches him that scarlet fever is the most fruitful cause of inflammation, and consequent disorganization, of the outer as well as the middle ear.

Section III.

INFLAMMATION OF THE MEMBRANA TYMPANI,

When existing unconnected with disease of the tympanal cavity, may rather be considered as belonging to External than to Internal Otitis. Such an insulation in the seat of inflammation has not been described by Itard, nor have Andral or Roche, in their very excellent articles on Otitis, alluded to it, except as a part of Otitis Interna. Dr. Kramer has a chapter on this affection, in which he treats of its acute inflammation, but more particularly dwells upon the chronic form. As the chronic disease of the membrane, and its consequences, are far from being rare, without evidences of a coexisting affection of the meatus, or of the tympanum; and as symptoms are occasionally presented to us, which would be expected to arise

from vascular excitement of this membrane, and in the course of a few days pass off, leaving no recognizable organic change, it appears reasonable to consider that an exciting cause may be applied to, and produce its effects in, the membrane, without implicating either the meatus or tympanic cavity. Kramer seems to have settled the question by direct experience; though he formerly, with other surgeons, thought the disease was always complicated with other affections. Most certainly it generally occurs as an extension from the auditory canal, which circumstance is to be expected, inasmuch as the same cuticular covering is reflected upon both.

When inflammation occurs in the tympanic membrane exclusively, the patient suddenly feels an acute pain at the bottom of the meatus, following the application of some irritant, which is generally cold wind striking sharply against the membrane, or the introduction of some foreign body, or perhaps a mechanical injury resulting from the removal of hardened wax or a foreign substance; or it may possibly be occasioned by too great a degree of vibration in consequence of unusual strength in the sound applied. The pain is accompanied by buzzings, as though something were fluttering in the ear, and by a lessened capability of hearing: and it is increased by loud sounds, by variations of temperature, and by pressure upon the ear; it becomes now and then unusually severe, which will continue for a few minutes, or sometimes much longer. When the membrana tympani is examined, with the assistance of a speculum and good light, it is found, in mild cases, to be slightly reddened, and vessels may sometimes be distinguished upon its surface. In severe cases the membrane will present an universal blush, and blood-vessels will be readily seen; it will be swollen and thickened, and the attachment of the handle of the malleus imperceptible. The milder degree of inflammation, which may be termed subacute, rarely excites general symptoms; and in the course of a few days the disease will subside. In the severe cases the local symptoms will be aggravated, with diminution of the ceruminous secretion of the meatus, which canal

otherwise retains its natural appearance; and fever will be produced.

The consequences of a higher degree of inflammation of the membrane, or when the affection has been long continued, may be anticipated. The disease may extend to the meatus, or inwards to the tympanal cavity; — the membrane may become thickened by the adhesive inflammation, either throughout its whole surface, or in several spots, presenting a rugged appearance, and which being vascular, may resemble indurated granulations: — a fungous growth may arise, which is however much more frequently produced by the chronic disease: little scales often exfoliate from the surface; — the affection may terminate in ulceration, injuring to a greater or less extent the cavity of the tympanum; — lastly, chronic disease may supervene.

It would appear from this history that the disease is first seated in the external cuticular membrane; and in its progress, or severer form, extends to the fibrous tissue.

This is the form and seat of inflammation, which has frequently been described as Otalgia or Ear-ache, which term we have seen has been applied to all acute diseases of this organ. The sudden accession of the pain, and its frequent subsidence without medicinal aid, with the difficulty in many instances of obtaining a good view of the state of the membrane, may afford an excuse for the surgeon considering it purely neuralgic; and even Itard, with his great experience, seems to have fallen into this error. It very probably, however,takes somewhat a neuralgic character, as in the milder cases the vascular excitement does not appear to correspond to the amount of pain, and of general sensibility of the organ, and the nervous connections of the membrane will favour such suspicion.

In the treatment it is of much importance not to mistake the inflammatory character of the disease, as the introduction of opium and other narcotics, which will benefit pure neuralgia, will here increase the excitement. In slight cases, the application of warmth and moisture over that side of the head — the maintenance of an equal tem-

perature — the action of a purgative — and, if there be no fever denoting increased action, an opiate at bed-time, particularly in the form of Dover's powder, will be generally successful in removing the malady. The more severe cases will demand the application of leeches to the neighbourhood; and the severely acute affection will require the strictest antiphlogistic regimen, both surgical and dietetic, including bleeding, as well general as local, with free purging, blistering, &c., to obviate the unfortunate consequences which may otherwise ensue. If the acute disease should continue, notwithstanding the treatment administered, by which ulceration or induration and thickening are threatened, the timely and judicious use of mercury to salivation may be attended by the same happy results, which are so conspicuous upon its administration in Iritis.

Section IV.

OTITIS INTERNA.

This term evidently should include inflammation of the labyrinth; but, as the immediate effects of acute disease in this intricate structure are not recognisable, and as they are only suspected in consequence of the cophosis produced, it has generally been confined to inflammation of the tympanum, where the disease may be early detected by attentive discrimination, and where its effects become apparent to every observer. It should therefore rather be called *Otitis Media.* That acute inflammation of the tympanal cavity occurs, commencing ordinarily in its mucous membrane, and extending to the other structures, almost every day's experience convinces us. Dr. Kramer has arranged it under two heads, that of Inflammation of the Mucous Membrane with Mucous Accumulation, and that of the Sub-mucous Cellular tissue; which arrangement corresponds to Itard's *Catarrhal* and *Purulent Internal Otitis.* This division is with difficulty recognised in the majority of acute cases, and experience leads the author to justify the criticism of M. Itard's re-

viewer in the Edinburgh Journal. The arrangement may be dangerous, if the partial, yet still excellent history given by Kramer, of a form of sub-acute inflammation of the mucous membrane, be received and acted upon as that which constantly occurs. He has written a good account of a frequently occurring condition of this tissue, but does not appear to have dwelt sufficiently upon its rapid extension : which extension he seems to imply, only takes place from the sub-mucous structure. As it is seen that the sub-mucous tissue may be inflamed without the surface of the membrane being involved in other parts of the body, and particularly in the meatus auditorius, which, however, must be considered as a comparatively rare occurrence, so it may be imagined that the cellular membrane of the tympanum may be the seat of phlegmon, independently of the rest of the tissue, but that it is not so frequent as Dr. Kramer appears to believe the history of most of the cases seems to prove. The inflammation generally commences in the mucous membrane, and may or may not extend to the structures beneath, or it begins simultaneously in both, and in its course may reach and destroy the periosteum and bone.

Every experienced practitioner of aural surgery must have seen two varieties of tympanal otitis; one slow in its progress, comparatively mild in its symptoms, and frequently recovered from; the other most severe, rapid, and generally destructive, either to the tympanum or the life of the individual. These varieties are rather to be considered as in degree, than in structural situation; and therefore it would appear, that if they are to be esteemed as distinct diseases, the appellations of Itard are preferable to those of Kramer. Mr. Saunders divided the complaint into three stages, without attempting to separate the disease itself: — 1st, A simple puriform discharge; 2d, A puriform discharge, complicated with fungi and polypi; 3d, A puriform discharge, with caries of the tympanum. These conditions are merely the effects of inflammation; and are rather to be considered as chronic.

The *causes* of internal otitis resemble those of the external disease; the most common is undoubtedly cold, applied through the Eustachian tube, — or perhaps

through the membrane, — or generally to the side of the head; the extension of inflammation from the tonsils or the fauces, from the external Ear through the Membrane, or from the membrane itself, — from the mastoid cells, though the reverse is generally observed; such spreading particularly occurs in the exanthemata; the affection arises also from an injury, accompanied or not with laceration, of the membrana tympani; and from mechanical irritation of the mouth of the Eustachian tube; disease extends to the tympanum likewise from the brain, whether the original complaint be spontaneous or traumatic; and it is excited by irritating medicinal applications when the membrane has been removed: mechanical violence may be applied to this cavity as elsewhere: but by far the most frequent cause is a cold wind blowing along the meatus, in a predisposed subject; in which event, the meatus is defended by its secretion from the effects of the *direct* application of the same draught of cold air, which *indirectly* affects the tympanum to serious disease. It is asserted that the sudden suppression of a distant discharge will excite disease in this cavity, corresponding to the supposed similar effect in the external Ear; and that it alternates with ophthalmia. It is quite certain that disease of the Ear, both internal and external, frequently accompanies, and appears to be in some measure modified, by affections of the eye; they are generally confined to the mucous membranes of both organs; are produced by the same exciting causes, and almost invariably occur in scrofulous children. A common opinion prevails, that loud noises, as the roaring of cannon, will break the drum of the Ear, and produce all the consequences of tympanal suppuration; it is not uncommon to meet with otorrhœa, from disease of this cavity, in old soldiers, but other causes than the noise of cannonade, have been in operation, to which the disease may be rather attributed. The rupture of the drum of the Ear, so often complained of, as being produced by the breaking of stones at the road side, ought with more propriety to be considered as an affection of the nervous portion of the organ; and the discharge that sometimes accompanies the deafness to be attributed to other exciting

causes. Scrofula is the great predisposing cause of internal otitis, which is not commonly met with in individuals, who have not this peculiar delicacy of constitution, excepting when excited by accidental causes. In like manner syphilis, and all debilitating diatheses, predispose to this affection.

It will be advisable to treat first of the severer degree of inflammation, with its acute effects; and then to discuss the milder, but very often the more insidious form of this disease.

§ The *symptoms* of the severe affection, to a certain extent, resemble those of otitis externa, differing in consequence of the structure affected; of their greater severity; and of the circumstance of the matter when formed not meeting with a ready outlet. The symptoms are at one time ushered in by a severe pain in the Ear, which is often neglected, and regarded as being what is commonly termed *Ear-ache*, and which may continue only for a few hours, or it may persist with occasional exacerbations, for two or three days; when it more or less suddenly extends to the whole of that side of the head. In other cases the symptoms commence with intense headache or insupportable hemicrania; the febrile excitement is most severe, the eyes are injected, watery, and intolerant of light; the countenance is flushed and anxious; the skin hot and dry; the pulse frequent and hard; the secretions are suspended; the pain becomes excessive, and extends throughout the whole head, but is more severe on the side affected, and the patient particularly refers, as the most painful part, to the bottom of the auditory canal; tinnitus aurium is a frequent distressing accompaniment; the pain is increased by noises, even the slightest, by the movements of the jaw, and attempts at deglutition; and it frequently shoots through the brain, and extends to the fauces; the disease is attended by delirium, often very violent at the onset, but towards the close becoming low and muttering, and by occasional rigors. In its progress, the inflammation spreads to the mastoid process, which becomes hot and painful on pressure, as well as to the pharynx, tonsils, &c., which are then tumefied and red-

dened. The severity of the symptoms frequently abates in the morning, a reaccession often accompanied by rigors coming on in the evening. The patient is also deaf on the affected side.

So far the symptoms, though indeed acute, are insufficient to distinguish inflammation of the tympanum, from the most severe form of external otitis: to perfect the diagnosis, it is necessary to ascertain that the auditory canal is free from disease; and to take into consideration the longer interval of time between the first accession of pain and appearance of discharge. In external otitis the mucopurulent secretion occurs in a few days, or even a few hours; in the internal disease, a week or more will elapse before any matter is discovered, and then it escapes suddenly either through a rupture of the membrana tympani, through the Eustachian tube, or through the ulcerated mastoid cells; whereas in the external disease it is preceded by a serous moisture.

This may be considered as the first stage of the disease, and is that of inflammation, terminating in suppuration. It sometimes happens that timely treatment in a good constitution so lessens the inflammation, that it terminates in a mucous secretion, or in resolution; but in the great majority of instances, it passes on to suppuration, and the escape of the pus may constitute the second stage.

The distressing symptoms are not relieved when suppuration is completed, in consequence of the pus being still retained in the tympanal cavity; no certain data therefore exist, by which it can be known that the secretion has taken place, until it makes its exit, which may happen in a week, or it may not occur until after two or three weeks.

The pus is discharged most frequently through the membrana tympani, either by rupture, to which it may be more prone in consequence of its inflamed condition; or, which is more common, by means of ulceration, and which often takes place to a great extent. Itard has supposed that the greater frequency of the matter being discharged through the membrane than the Eustachian tube is as ten to one. The first stage of the inflamma-

tion generally closes the Eustachian tube by adhesion, and hence the difficulty of the matter finding its exit in that direction. When the suppuration has extended back to the mastoid cells, the integument covering the process assumes a dark livid colour, often attended with an indistinct fluctuation; ulceration, or even sloughing may occur, or the abscess be opened artificially, when the matter mixed with blood finds an escape, accompanied by exfoliations of the cells. The pus in all cases is offensive, and particularly disagreeable to the taste when it passes into the throat; occasionally the ossicula are discharged at the same time through the membrane or mastoid process, but they usually come away at a subsequent period.

When the case is favourable, the patient experiences a subsidence of his distressing symptoms as suddenly as the escape of matter occurs, and the improvement is in proportion to the freedom of the discharge, which varies either in consequence of the great consistence of the matter closing the opening in the membrane, or of inspissated fibrin, in the form of little crusts falling against the aperture. On examination of the Ear the perforation may be generally seen, but sometimes that is impossible, in which case, however, air may usually be forced through it from the Eustachian tube, forming bubbles in the matter; the absence of this sign is not to be depended upon, as a closure of the tube will prevent the success of the experiment. When the pus finds its way through the tube, by forcing through the obstruction, or by ulceration, the quantity is sometimes so great, and so suddenly discharged, as to resemble the breaking of a tonsillitic abscess, and the muco-sanio-purulent matter is expectorated; at other times it escapes by degrees, and there is a constant disagreeable sensation in the throat, with continual spitting. Happy results may be expected when the matter is discharged into the throat, but when it escapes into the meatus, or through the mastoid process, it is almost certain that the ossicula, wholly or in part, will be lost, and that a troublesome chronic otorrhœa will continue for a long period, sometimes even during life, giving rise to deafness more or less complete, the

extent of which depends upon the amount of disorganization. This part of the subject will be more advantageously considered, in treating of the chronic diseases of the tympanum.

It but too frequently happens, that the Surgeon witnesses an unfavourable termination to this painful form of disease; the severe symptoms assume those characters indicating inflammation of the membranes of the brain, and after passing some hours, or a day or two, in a state of delirium more or less raving, the patient falls into a condition of coma and expires. The symptoms alone are sufficient evidence that the disease has extended to the brain, and it appears, in most instances, to make its way either through the roof, or the posterior wall of the tympanal cavity. In cases where this result is very rapid, the inflammation may extend from the lining membrane of the tympanum to the bone, and thence to the dura mater, and thus life may be destroyed by meningitis, or phrenitis; while in other cases the disease may terminate in suppuration either between the cranium and the dura mater, or between the cerebral membrane themselves, or in the substance of the brain. Dissections of these cases, however, prove that the upper or posterior wall of the tympanum is generally destroyed, either by necrosis, or more frequently by caries, which condition corresponds to the more gradual extension of the disease to the brain; and particularly to the fact, that these fatal cases usually result from acute inflammation excited in a chronic affection.

As examples of the acute form of tympanal inflammation, the following cases may be inserted. The first history is given in the words of the Surgeon who attended the patient throughout.

"Miss M. N., aged five years, born of scrofulous parents, had been subject to pain in the Ear for two years, which subsided with a discharge from the meatus, and was considered by her friends as a common Ear-ache, to which no treatment was directed beyond a poultice and warmth. It was observed by her mother than when free from the pain, she always had a discharge from an erup-

tion behind the Ear. This little girl, with slight previous indisposition, was momentarily seized, on the 21st March last, with sickness and convulsions, which lasted for more than an hour; she was quite sensible and recovered when the Surgeon saw her, and no trace nor evidence of epilepsy remained. From the description of the attack it was thought right to bleed her, and to direct the almost daily application of leeches, with mercurials and aperients. For some days she appeared cheerful, and seemed to be going on well for a week, when she grew less cheerful and restless at night, complaining of pain in her Ear; now active treatment was instituted; and leeches to a great extent, with calomel in large and repeated doses, and continued blisters at the side of the head and behind the Ears, failed to give the least relief, and she died comatose, with all the symptoms of matter on the brain on the 20th April. The pupils were fully dilated, and sensibility to light was lost; the pulse from thirty to forty, sometimes hurried, and then sinking down to that standard, generally irregular, as if the heart had no power of acting; the pain, so long as the little sufferer was sufficiently sensible to make it known, was always referred to the affected Ear. The head was not allowed to be examined, but the evidence of scrofulous disease was so strongly marked, that the attendant feels confident of the existence of suppuration, communicated by inflammation of the internal cavity of the Ear to the dura mater."

It is exceedingly unfortunate that a *post-mortem* inspection in this case was not permitted, as though no doubt can exist that it would only have furnished another to the many instances, of disease extending from the tympanum to the brain, which are found reported in the records of our profession, yet it would have been interesting to have noted the exact extent and situation of such lesion; this case affords another example of the general strumous tendency of individuals thus afflicted.

A professional friend, to whose case of suppuration into the meatus allusion has already been made, furnishes this history of the loss of his hearing in the right Ear: —

"In the autumn of 1828, I was in a very weak state of health, in consequence of the confinement of my apprenticeship, and the loss of the constant and free exercise in the open air, which I had always before enjoyed, and something may be attributable to an alteration of diet. While attending the funeral of a dear relative, and suffering from distress never before experienced, I was exposed to a current of keen wind upon my right Ear. I experienced pain in it, which on the second night became very acute, and in the morning I found a discharge of pus from the meatus; this discharge continued for a length of time, sometimes offensive, sometimes not, and the malleus at last was lost, which I kept for some time. I think the other bones are away also, for I am perfectly deaf of that Ear. I remember that when I sometimes from uneasiness pressed the meatus from behind, and forced the pus through the Eustachian tube, I had a sense of giddiness in my head, as if there were pressure upon the brain. The discharge continued more or less, during all the following winter, and in the next summer I had a large abscess behind the Ear, which was long troublesome. At length this healed, and the discharge from the meatus diminished, and at last ceased entirely."

Upon examination of the affected Ear, the Author finds that fungoid granulations have sprung up from the tympanum, and bottom of the meatus, which so far obliterates and protects the cavity, as to render its inner wall imperceptible, it is therefore impossible to say whether the stapes is removed or not; although the patient thinks it is, yet, as vibrations communicated through the bones of the head are distinctly heard on that side, it is more than probable that the ossiculum still remains, as its exfoliation is generally, though not always, attended with ulceration or laceration of the membrane of the fenestra ovalis, and consequent loss of the aqua labyrinthi.

"J. B., ætat. 21. — Housemaid, of short stature, very dark complexion, and strumous appearance, had been long subject to violent Ear-ache, and pains in the head,

and on one occasion previously to her last illness, a quantity of blood came from her Ear. On a Monday, in April 1838, whilst out walking, she was attacked with severe pain in the right Ear, which was accompanied by a considerable discharge of blood from the meatus. (She thought the blood was pure and unmixed with matter.) Leeches were applied to the head but gave little relief, and on the same evening, or on the following morning, blood was taken from the arm with apparent benefit. On Tuesday evening she said that the pain, although still severe, was diminished; at a latter hour she became excited and restless, talked almost incessantly, and in a wandering manner, and insisted upon leaving her bed and going down stairs. From this time she became worse, and on the Saturday following was conveyed to the house of a relation, still complaining of much pain in the Ear and side of the head. She had become excessively weak and drowsy. The tongue was loaded and rather dry. In fact, typhoid symptoms were commencing. She died rather suddenly early in the afternoon of the Monday or Tuesday following.

"No *post-mortem* examination was made.

"It was stated soon after her death by her fellow-servant, that she was much accustomed to spirit drinking."

This case, which towards its close, was mistaken for contagious fever, though evidently Otitis extending to the brain, is important as denoting the facility with which the original disease may be overlooked.

"S. R., ætat. 12 years, an apparently healthy girl, had been the subject of attacks of pain and deafness in the right Ear for the last twelve months, recurring every two or three months, and lasting for a day or two, but *without* any discharge, the pain extending to the back part of her head on that side, but not so severely as to attract serious attention until last *Sunday*, *October* 23*d*, 1831, when a more severe attack accompanied with a discharge commenced, and was imputed by her mother to the child having taken cold after being in a shower of rain without any covering to her head. When first seen on the morn-

ing of Friday, October 28, she was sitting up with her head reclining on the right side, and complaining of *great pain in the Ear from which there was a purulent discharge;* there was pain on pressure behind the Ear, more particularly over the mastoid process, and slight redness about the tonsils and uvula, though she had never complained of uneasiness in the throat, or any difficulty in deglutition. There was anxiety of countenance, a quick pulse, and general febrile excitement. For the three following days the symptoms remained unabated. The pain over the mastoid process had increased, and on Nov. 1st a puffiness was there detected; on Nov. 2d, fluctuation behind the Ear having become evident, a puncture was made, and a quantity of stinking purulent secretion discharged. She had had a distinct rigor in the morning, and the fever continued with extreme restlessness and anxiety of countenance. Nov. 3d, continued much the same until this evening about eight o'clock, when she had a convulsion lasting only a minute or two, but remained insensible for a short time after. On visiting her about half an hour afterwards, she was lying on the left side, breathing quickly and anxiously, the pulse exceedingly hurried, and occasionally irregular and intermittent. Pupils natural and sensible to light. Tongue furred and white,— had an involuntary stool just before the convulsion,— complained to-day of difficulty in swallowing, for the first time,— the countenance expresses the greatest anxiety, and she is moaning with pain. The Ear discharges abundantly, as well as the opening made behind it. Had another rigor this morning,— shuns light and conversation as if it annoyed her. Nov. 4th, no return of the convulsion, but she is lying in a partially comatose state, seeming disinclined to answer questions, and speaking hurriedly. The countenance still expressive of the greatest anxiety, — tongue white, general pyrexia and thirst. Bowels open twice to-day, pulse quick but not irregular, nor intermittent as yesterday, — complains of great pain down the back, and in all her limbs, — *a quantity of fetid pus* discharged by pressure from behind the Ear. This morning, Nov. 5th, — all the symptoms continue unabated, with great restlessness and irri-

tability, constantly crying with pain Tongue has now become red and glazed; bowels had been once opened. Nov. 6th, — Died this morning, (Sunday,) about ten o'clock, having continued sensible until her death, but lost her speech for six hours previously.

"*Autopsy twenty hours after death.* — Small abscess under the pericranium in a line with the longitudinal sinus. The cellular structure under the occipito-frontalis muscle inflamed, and abscess behind the right Ear. The vessels of the membranes of the brain much congested. The pia mater covering the inferior edge of the middle lobe of the cerebrum much thickened, and a small quantity of pus effused under it. A large abscess in the right lobe of the cerebellum produced by ulceration of the petrous portion of the temporal bone, which had ulcerated from the cavity of the *Tympanum and the Mastoid cells*, just above the grove for the lateral sinus; the dura mater was found separated from the bone at that part by pus effused beneath it."

"Mr. J. V., aged twenty-seven years, had been the subject of suppurative discharge from the right meatus auditorius from the age of fourteen, accompanied by occasional pain in the ear, and about that side of the head. In January, 1822, he had an attack of severe pain about the ear, and a large abscess formed behind it, burrowing under the temporal fascia. This was opened and all did well. He frequently complained of pain, but not so severe as to induce him to seek medical relief, and also had a constant discharge from the Ear, which was occasionally peculiarly offensive. At this time I was spoken to on the subject, and recommended him to frequently syringe the Ear with warm water, and not to neglect a severe pain, he might at any time experience. On Saturday, August 14th, 1830, I was requested to see him, and was told that he had taken opening medicine for a day or two, and that he believed he had taken cold whilst bottling wine in a damp cellar. He now complained of headache, and his pulse was frequent and skin hot. Leeches were ordered to be applied to the head, and a purgative with saline

medicine prescribed. He was found much in the same state for several days subsequently, but on the evening of the 20th, all his symptoms became more distressing, there was a degree of stupor with great restlessness, and the *pulse was extremely small and weak.* On the 21st he appeared somewhat relieved, and much more easy and tranquil. 22d. — There was now considerable want of power; his pulse was feeble but not frequent, the tongue dry and of a brownish colour. The bowels had been opened. On the 22d, in the evening, he seemed much worse, having considerable pyrexia with coma and restlessness. Leeches were again ordered to the head, and small doses of *mag. sulph.* every four hours. 23d. — Still evidence of considerable head affection, — and comatose; he could be roused when spoken to, and appeared conscious for a short time, but would soon relapse into the same stupid condition. Up to the 29th he went on much in the same manner. The bowels, however, became very torpid, for which enemata were used. Leeches and evaporating washes to the head were had recourse to. 30th. — The head very much affected, and was extremely hot to the hand. *At this time there was a trifling discharge from the right Ear*, and in the night he had a distinct rigor, which was followed by coma. 31st. — He was comatose, the surface of the body cold, more particularly the hands and feet, he was breathing stertorously, the pulse extremely feeble, and the bowels very inactive. In the evening reaction took place, the head extremely hot with very great restlessness, the pulse very quick, and the tongue dry and brown. Sept. 1st. — Appearing much in the same state, — the bowels had not acted, the pulse feeble and about eighty in the minute, hands and feet cold, great restlessness with stupor. On the evening of the 2d, he was attacked with considerable embarrassment in his breathing, which continued some time; otherwise, he went on much in the same manner, and died on the morning of the 3d about ten o'clock.

"*Autopsy at seven in the morning of the 4th.* — The membranes of the brain presented nothing unusual, — there were about two ounces of clear serum in the ven-

tricles; on drawing the crura cerebri and cerebellum backwards with the view of cutting through the medulla oblongata, the pressure of my fingers on the right lobe of the cerebellum burst an abscess, and a large quantity of offensive dark coloured pus escaped. On closer examination the dura mater was found separated from the posterior face of the petrous portion of the temporal bone, which was in a state of ulceration communicating with the cavity of the tympanum.

"In the above case, the slow state of the circulation, and the torpid condition of the bowels, and the formidable disturbance which took place towards the end of the case to the respiratory process, are points which should be borne in mind, and occupy our thoughts."

These two cases, which were supplied to the author by the same friend, clearly illustrate the usual course of acute Otitis of the middle Ear, excited upon a chronic disease, and extending its ravages to the sensorium.

"Miss B., ætat. 9.— Had never been of a strong habit, but on most occasions had enjoyed perfectly good health until three years since, at which time she laboured with scarlatina. After her recovery she became subject to pain in the left ear, accompanied with deafness, and a discharge of thin purulent matter of a fetid odour. The deafness increasing, her friends consulted an aurist, who ordered an injection, a strong solution of sulphate of zinc, to be thrown into the ear, and the use of it to be continued for some time; however, the benefit derived from it was trifling. On Monday, the 19th of March, 1838, the injection having been continued about a month, the pain in the ear became more acute, and extended somewhat higher up the side of the head than at former periods, and it was increased on pressure being applied over the mastoid process of the temporal bone, — pulse eighty and compressible. 20th. — The pain is more severe than yesterday, and it extends over the greater portion of the left side of the head; complains also of her eyes being weak, and not able to bear the light of a can-

dle. 22d. — The right pupil is somewhat more dilated than the left, still, however, obedient to light; there is also an involuntary movement of the arm and leg on the right side, but during the intermission of the latter, she still retains power over them. About nine o'clock, P.M. she called for some coffee, which was immediately rejected from her stomach, — pulse 70, compressible and laborious.

"She continued perfectly sensible until one o'clock the next morning, when she expired.

"*Autopsy.* — Permission was obtained to examine the head only. The bones of the head were remarkably healthy, with the exception of the petrous portion of the left temporal bone, the anterior surface of which was of a dark red colour from increased vascularity, the posterior was slightly ulcerated. After sawing it through to expose the internal Ear, the aural surface of the petrous portion was pretty generally coated by puriform matter, and the membrane lining the meatus auditorius externus was in several places even ulcerated.

"The tympanum and the labyrinth of the ear appeared to have suffered from ulceration, which had been in process for some time. A cavity had formed within the mastoid process, which contained about a drachm of puriform matter of a fetid odour.

"The dura mater of the brain was pretty healthy, with the exception of a part of it immediately in contact with the petrous portion of the temporal bone, where it was firmly adherent, and required some force to separate it; it was also thick, dark in colour, and covered with puriform matter.

"The arachnoid membrane throughout presented a slight degree of opacity, and beneath it there was a considerable quantity of serum effused, and the portion surrounding the diseased bone, was thickened and covered with lymph, which was principally within its cavity. The pia mater was increased in vascularity, and somewhat more adherent to the brain itself. The convolutions of the cerebrum were well developed, and by no means depressed, whilst on making an incision into the hemisphere,

they appeared increased in vascularity. The right and left lateral ventricle each contained about four drachms of transparent serum. That part, the left lobe of the cerebellum, which lay in contact with the diseased bone, was nearly altogether softened, and formed into one continuous mass, which was pretty free from any admixture of puriform matter, whilst the remaining undestroyed portion of the lobe was increased in vascularity, and in a state approaching to softening."

The fatal consequences of improper interference with chronic disease of the exposed tympanum, is well illustrated by this case, in which it appears that the membrane being ulcerated, the astringent lotion was introduced into the tympanic cavity, which it excited to active disease. Within a few days the Author was consulted by a gentleman, who had suffered severe pain from the introduction of some drops into his ear by an aurist in extensive practice; it was ascertained that he had a large aperture in the membrana tympani.

To these cases of acute inflammation of the tympanum, several others might be added which have fallen, either directly or indirectly, under the notice of the Author of this paper, as well as many admirably reported by Dr. Abercrombie, by M. Itard, and by Dr. Duncan and other writers, in the different journals; but as most of them have supervened upon chronic disease of the tympanum, it will be better to make brief allusions to some of them when treating of that part of our subject. It may be permitted, as elucidating another mode of termination, to transcribe a case which Dr. Kramer has quoted from Schmucker:

"A soldier, named Hittberg, had suffered for many years from pain in his ear, discharge of pus, and great difficulty of hearing. Notwithstanding this, he was appointed to his regiment; but three weeks afterwards, he had violent fever and dreadful pain in the right ear. In the left ear the pain was supportable. A bleeding, — emollient poultices to the right ear; a second bleeding, — blisters, and enemata, in some measure diminished the

pain, which, however, always returned, though the discharge was never interrupted. During the most violent pain, a blister had been applied to the mastoid process of the affected side, and thus a slight elevation had been induced over this spot, which indistinctly fluctuated. After repeated applications of emollient poultices, an incision was made through the swelling, an inch long, down to the bone. The bone was rough, worm-eaten, and presented an opening, from which, however, only a small quantity of pus escaped ; but on introducing a syringe, and injecting some pectoral infusion, pus escaped through the Ear into the mouth, accompanied by a very peculiar sensation. Great relief from the pain in the head followed immediately on this ; the opening in the wound discharged a good deal of pus. The wound was dressed with dry lint, and the depuratory injections were repeated daily ; in eight days the discharge had ceased, and in three weeks the wound of the integument was healed. The patient never experienced pain in the head again, and his hearing, compared with what it had previously been, was even much better."

The treatment of the severe form of acute internal otitis, whether it be primary or consecutive, must be conducted on the strictest antiphlogistic rules; bleeding generally and locally, until an effect is produced upon the symptoms, or at least upon the pulse ; blisters in the neighbourhood of the head, and when the more severely acute pain in the Ear has been diminished, they may be applied behind the auricle, and often with great benefit; cathartics, even somewhat of an irritating character, are requisite as depletants, and also as derivatives; and if the disease threatens to be obstinate, or to extend, which in the majority of these serious affections will occur, mercury should be given to excite early salivation, and with this view, from one to three grains of calomel, every two, three, or four hours, will probably be the readiest form of exhibiting this valuable medicine, and particularly its influence will be expedited by the previous bleedings and purgings. The local treatment, in addition to the leeching, &c., will consist in the application of warmth and

moisture to the side of the head; and in the careful avoidance of irritating the meatus by injections or otherwise. When the brain unfortunately becomes implicated, then the head must be shaved, and evaporating lotions freely applied, either warm or cold, as may be the more soothing to the patient's feelings.

As when the disease arises idiopathically, not being preceded by chronic inflammation, nor by the milder affection, it generally happens that pus accumulating in the tympanal cavity, and becoming decomposed, more readily produces most important aggravation of the symptoms, and is the frequent cause of inflammation extending to the brain or its membranes, so does evacuation of the matter as soon as it is formed, become a circumstance of immense interest, and upon which, perhaps, the patient's life may depend. In consequence of the urgency of the symptoms not abating, when suppuration of the tympanum has taken place, and from the probability of the rigors, when present, depending upon irritation of the brain, it is extremely difficult, and often impossible, for the nicest discrimination to decide accurately upon the presence or absence of such accumulation; and its existence is frequently unknown, and, by the inexperienced, not even suspected, until it makes its way out in one of the three modes already alluded to, or until it has occasioned fatal disease of the sensorium. If, upon examination, the membrana tympani appears opaque, and less than usually concave, and particularly if it has assumed a convexity indicating pressure from within; if pain, and tenderness upon pressure, exist in the mastoid process, and especially if the integument covering it be tumefied and reddened, showing the probability of the inflammation, and perhaps also of suppuration having extended to its cells; if air cannot be forced into the Eustachian tube by an expiratory effort during the closure of the nose and mouth; if, upon sounding the tube, (supposing the patient can bear the operation,) it is discovered to be imperforate and painful; and if the symptoms have been progressive, notwithstanding the employment of active measures, the Surgeon will be justified in the endeavour to procure an exit for the pus supposed

to have accumulated in the tympanal cavity, though that supposition may be incorrect. The most favourable mode of evacuation, when it can be procured, is through the Eustachian tube, as it may then be possible that the ossicula may be saved, and with them the general functions of the tympanum. Itard, Andral, Roche, and others, prescribed for the removal of an obliteration of the tube in these cases, the forcible use of gargles variously medicated, — the application of tobacco fumes by means of a violent expiration, — the vapour of some emollient decoction, or injections carefully introduced into the tube; these remedies as might be expected are rarely successful. It becomes then a question of moment to decide to what extent the Surgeon may apply force, by means of the Eustachian tube catheter, in order to break through the obstruction, as there exists considerable danger of increasing the inflammation, and even of rupturing the tube; in all cases the operation will be productive of great pain. When the adhesion of the parietes is so complete as not to yield to moderate pressure, it will be probable that the disorganization of the tympanum has proceeded so far that the membrane will be ulcerated, and the bones eventually thrown out. The safer plan will, therefore, be, to discharge the pus through a perforation of the membrane; which practice will not admit of hesitation, when the membrane is protruded into the meatus. The Surgeon will more readily adopt this procedure, as it is the usual mode of evacuation, when the disease is left to the efforts of nature. An abscess formed over the mastoid process in consequence of the inflammation extending through the bone, is of course to be immediately opened, and if it should communicate with the cells, the matter will be evacuated; and when such communication does not exist, if the bone be dead, as will generally be the case, an opening may be made through it, or an aperture too small for the purpose of allowing the pus freely to flow out may be enlarged. In these cases, the bone is ordinarily so much diseased as to be easily cut with a knife. When pus is lodged in the mastoid cells, having either been secreted there, or flowed into them from the tympanum, in consequence of the opening

of communication between these cavities being in the upper part, the fluid cannot pass into the tympanum, unless ulceration of the bone has previously occurred. Dr. Burne has therefore recommended, that in these cases the mastoid process should be perforated "by any fit instrument, so as to form a free external communication with the cells, through which injections may be passed." The escape of the matter, through either channel, may be facilitated by injections of tepid bland fluids, when it is too thick or inspissated to flow out naturally. The after treatment of the abscess, and the caries of the bone, which is sometimes very extensive, must be conducted upon general principles; the Surgeon, however, never losing sight of the probability of the disease in every stage being exasperated by any exciting cause, and which thus may endanger the brain.

§ The *milder* form of acute Otitis Interna,—the inflammation of the mucus membrane of the middle Ear, with accumulation of mucus of Dr. Kramer, — the internal Catarrhal Otitis of M. Itard,— and variously named by other Authors, from the particular consequence of the disease which attracted their notice, does not in the greater number of instances long remain confined to the mucous membrane; it extends gradually to the sub-mucous tissue, which becomes thickened, and the membrane itself more or less villous, assuming a chronic form, and affording a chronic secretion. In very many cases, the milder affection becomes aggravated into a severer degree, upon the application of an exciting cause, or from an interruption to the general health, when suppuration, and ulceration of the tympanal membrane, with loss of some of the bones, will be produced. The disease may also be excited to the severer form, and terminate in the different modes we have just discussed.

Sometimes without any evident cause, but generally in consequence of cold, or following mucous inflammation of the fauces and tonsils, the patient experiences a dull heavy uncomfortable sensation in the Ear, attended with obtuseness in hearing; the uneasy feelings vary, and may consist either of sharp pain, or of some degree of insensibility in the organ, but the diminution of func-

tion is constant though differing in extent. Frequently there is irritation in the outer meatus, sometimes with a lessened secretion of wax; and the patient now and then forces air through the Eustachian tube to remove some uneasiness, which effort produces pain. The sensations and hearing are influenced by circumstances of temperature, of the atmosphere, of motion,—they are improved in warm dry weather, and when the excited action of the skin relieves that of the mucous membranes; the symptoms are much increased by any catarrhal affection, or interference with health from any cause, and then there is often a discharge of mucus from the Eustachian tube into the pharynx, more or less disagreeable, and which is expectorated with relief.(*a*)

(*a*) "Predisposition to mucous engorgement of the middle ear is," according to Kramer, "most frequently seen in childhood and youth; (I have scarcely ever met with it in old age;) and also in scrofulous constitutions, where there is a disposition to mucous engorgements and catarrhal affections in general; though even the strongest constitutions do not exclude the development of a local catarrh, confined to the middle ear.

"The most frequent, or rather the only exciting cause, is the application of cold to the head and feet, the greater or less intensity of which determines the degree of development of the disease in particular individuals.

"Frequently, only one ear is affected; but if both are, not only the dulness of hearing, but also the difficulty of overcoming the disease, is always greater in one ear than in the other.

"It is surprising when we consider the extreme narrowness of the Eustachian tube, and the frequency of catarrhal affections of the nares and pharynx, that mucous engorgement of the former canal should, on the whole, be rare. It is evidently of most frequent occurrence during moist autumns and springs, and in moist climates, *e. g.*, in sea towns, from which places the greater part of those patients have come to me; viz., from Hamburgh, Stettin, Swinemünde, Danzig, Memel, Cüstrin, &c. Under these circumstances, I cannot understand how the so-called English aurists, who must very frequently meet with the disease in a foggy city, like London, should have scarcely any notion of the proper diagnosis of the complaint, and still less of any rational mode of treatment."

The prognosis is regarded by this author as altogether favourable.

These symptoms frequently assume a chronic condition, continuing for months or even years, with slight variations arising from causes more or less evident. At other times, and perhaps even more frequently, as the experience of the Author of this treatise leads him to believe, notwithstanding the high authority of Kramer is opposed to that opinion, — the inflammation assumes a more acute form, giving rise to the corresponding symptoms of pain, extending in the directions already mentioned, — frequently of giddiness, of deafness, of fever; and in an indefinite time to a discharge of muco-purulent matter, at first tinged with blood, afterwards clearer, which having passed through the ulcerated membrana tympani escapes from the meatus, and which is often accompanied with the malleus, with or without the incus, and sometimes also with the stapes. During this progress, which occasionally extends over many years, in consequence of becoming chronic, the disease may take on the severe form, and produce the sad consequences thereupon attendant; and even after the pus and ossicula have escaped, a chronic discharge is frequently still continued.

When the inflammation of the mucous membrane continues without producing the above effects, an accumulation of mucus takes place in the cavity, giving rise to dulness of hearing, without producing complete deafness; this effect will not only be in proportion to the quantity contained in the cavity, but also in the ratio of its density; the mucus is likewise frequently mixed with films of fibrin, secreted by the turgid membrane, and which tend to clog the Eustachian tube, and thus confine the fluid, which appears to be proved by the circumstance of little white patches, as they are called by the patients, being spit out by hawking, when some mucus follows, with immediate improvement in hearing. Such mucous accumulation is a more frequent cause of hardness of hearing in persons habitually exposed to cold than is generally imagined, and which it is the more important should be well understood, as surgical art can often do much towards its removal. This disease is frequently accompanied by thickening of the lining membrane of the Eustachian tube, or by its temporary closure in conse-

quence of the accumulation extending into that canal; in which cases the diagnosis will be increased in difficulty. The membrana tympani is sometimes, though very rarely, so pressed upon internally, that its protrusion becomes evident upon examination by the meatus.

The healthy condition of the auditory canal and of the tympanic membrane — the perfect function of the labyrinth, as indicated by the perception of vibrations conveyed by the cranial or facial bones — the different sensations excited by the patient forcing air into the Eustachian tubes, the cracking in the healthy ear, the gurgling in that diseased, or the absence of all sensation if the tube be too far obliterated for the transmission of air — above all, the introduction of the Eustachian tube catheter (in the way presently to be described), readily removing what obstruction may have been formed: — the air forced through the catheter passing into the tympanum with rather an unusual difficulty — the mucous *râle* produced by the air entering the cavity and mixing with the fluid, instead of striking somewhat loudly against the inner surface of the membrane, and which may be heard, as first shown by Laennec, with the stethoscope against the mastoid process, or by the ear of the operator in contact with his patient's; — the often partial escape of mucus into the throat upon the admission of air into the tympanic cavity; and the more frequent and greater discharge upon the injection of warm water, with an immediate improvement in hearing, will satisfactorily prove the presence of mucus in the tympanum, which will be still more decided if the stylette or bougie passed through the catheter into the cavity be smeared with the mucus. The absence of the whole of these signs does not prove the contrary, as a stricture of the tube will render the investigation nugatory.(*a*)

(*a*) Under the head of *Diagnosis*, M. Deleau points out the effects of douches of air on the middle ear in a state of disease. "The *bruit de pluie*, or sound of rain, produced by a moderate douche, is sometimes accompanied or followed by a slight pain and momentary increase of the dulness of hearing. It indicates an exaltation of sensibility — it is a commencement of inflamma-

The milder form of Otitis Interna becomes a common cause of stricture of the Eustachian tube, by exciting adhesive inflammation and thickening in the submucous tissue, which effect and its treatment are to be described under the head of Chronic Otitis.

This form of disease of the Middle Ear is so common, that it becomes necessary to select cases for elucidation from the many that are reported, and are witnessed by the practitioner of surgery, rather than to describe all which come to his knowledge. Such being the case, the Author will confine his illustrations to one or two instances that have lately fallen under his cognizance.

The Writer frequently examines the ears of Miss M., who is partially deaf; in whom the membrana tympani of the left ear is completely removed, and likewise the malleus and incus, the stapes being readily seen fixed in

tion. This state can only be recognized and well appreciated when one is certain of having performed, without hesitation and fumbling, the operation of catheterism; for it is easy to suppose that an awkward hand might, by throwing in the air with too great force, give rise to this morbid irritation in the ear: in the same way that too strong light would over-irritate the retina predisposed to inflammation by a delicate operation."

"Sometimes, the catheter is engaged in the tube some lines only; if we do not take precautions in withdrawing the stylette, the end of the catheter escapes into the pharynx. In this case the air which serves for the douche is dispersed in the pharynx; if the catheter remains in the Eustachian tube, the air regurgitates immediately after having arrived at the extremity of the catheter, and makes the lips of the guttural orifice of the Eustachian tube vibrate. I call the sound which is heard, and which is more or less mucous, *bruit du pavillon.* When it is simple, it indicates a stricture or a complete obstruction, situated in the guttural half of the tube. When the obstacle to the introduction of air into the tympanum is near that cavity, we perceive, on applying our ear to that of the patient, the *bruit de la trompe.* If the douche is given at the pressure of about one atmosphere, both the *bruit du pavillon* and *bruit de la trompe* will be heard simultaneously. The *bruit de la caisse* is more or less mucous; it is general or confined to one point of the tympanic wall. Little practice is required to appreciate the different characters of it." pp. 133-134.

its position above the promontory; the wax is secreted in the outer Ear, in rather more than normal quantity, but healthy in quality. In the right Ear a small circular portion of the membrane remains attached to the outer boundary of the cavity, the malleus is lost, and the incus is most distinctly seen united to the edge of the mastoid cells by its short crus, and by its long process to the stapes (Plate XII., fig. 12). In the right auditory meatus small pustules occasionally form, which for a short time slightly increase the cophosis. This lady, last year being out of health, was much annoyed with 'noises in the head,' and her hearing was still further impaired during their continuance, which symptom doubtless arose from an erethitic affection of the auditory nerve. She can hear tolerably well with the right Ear, and to some extent with the left, though not so well as she otherwise might, in consequence of that ear being allowed to fall into disuse from its greater imperfection than the other, and of the greater accumulation of wax. On requesting a history of the early symptoms, the patient writes, that she 'recollects imperfect hearing at nine years old (she being now upwards of thirty) — discharge of blood from the left ear at that period, and several years afterwards — no recollection of pain or uneasiness attending it — took a violent cold from getting wet in an open carriage, and an abscess formed in that ear — the pain was so severe as to produce delirium — it was succeeded by giddiness so great as to prevent lying in bed without holding, attended with considerable fever — the giddiness continued for many months — never heard but slightly with that ear afterwards — a discharge of matter from it for a great many months, but no pain or uneasiness, unless meddled with — nothing ever burst in the ear — no recollection of any bone coming away — the deafness came on imperceptibly with the left ear, until an abscess, occasioned by cold, destroyed the hearing entirely — the throat was always sore at that time. She does not hear well with the right ear, the membrane being gone — never had any uneasiness in that ear until within the last twelve months.'

Amelia Rattenbury, aged fourteen, of a scrofulous habit, 'when four months old, laboured under violent pain and inflammation in the right ear, which lasted ten or twelve hours, when an abscess broke and discharged a teaspoonful of pus daily for three or four days. She has had occasional pain and discharge of purulent matter ever since.' Upon examination, it was found that the membrana tympani was completely lost, together with the malleus and incus, leaving the head of the stapes exposed to sight. She was unable to force air into the tympanum through the Eustachian tube; the catheter readily entered the orifice of the tube, but required a slight force for its complete introduction, when an obstruction was removed, and she thought she could immediately hear on that side; upon blowing with the mouth into the catheter, the air easily found its way through the external auditory canal. The other ear being healthy, it was not likely that what improved hearing could be obtained, by the removal of the obstruction of the tube, would be much appreciated; but as the girl thought her hearing was increased by passing the instrument, it was continued occasionally. In this instance the disease which disorganized the tympanum, has also occasioned a slight stricture of the tube.'

Although when the Author first saw Amelia Rattenbury, her disease was in a mild condition, yet its previous state would justify the case being classed with those of the severer form.

The first case appears at the commencement to have been a catarrhal affection of the tympanum, exasperated into suppurative inflammation by cold; and it affords a fair example of a very common progress which the disease makes. Kramer has detailed several interesting cases of mucous accumulation in the tympanal cavity, producing deafness more or less complete, some of which could be temporarily relieved by the patients forcing air through the Eustachian tubes, which, displacing a portion of the mucus, thereby afforded the membrane of the tympanum an opportunity for increased oscillation. The Writer of this paper has to-day seen a case of engorge-

ment of the tympanum complicated with diseases of the outer Ear, in which air was easily thrown in through the Eustachian tube, occasioning a gurgling noise, and attended for a few minutes with improved hearing.

The accumulation of mucus in the tympanum may become chronic, continuing for many years, occasioning no other inconvenience than deafness, and sometimes an occasional discharge into the pharynx; but still the danger of acute disease being excited always exists.

The observations that have been made relative to the milder form of Otitis Interna, are applicable to similar affections both of the mastoid cells and of the Eustachian tube, extensions as they are of the tympanal cavity.

Probably, in every case of mucous accumulation, the mastoid cells are also more or less affected, and certainly the effusion may take place there; and if it pass at all into the tympanal cavity, it may be merely to an extent insufficient to materially influence the function. Such a case is also peculiarly predisposed to acute inflammation, which may terminate in suppuration, and occasion a carious condition of the bone, often implicating the tympanum in its course, and frequently leaving a very troublesome disagreeable sinus.

The general effect of this inflammation upon the Eustachian tube, is the formation of a *stricture*, which must be noticed hereafter; it may also occasion ulceration, either confined to the mucous surface, or, as dissection has proved, extending to the cartilage. This canal in which Otitis Interna frequently originates, is always more or less implicated in the progress of the affection; and it is not at all uncommon for the disease to be confined to the tube, in which case it is most generally the consequence of an affection of the throat. The Author has seen many instances in which acute inflammation of apparently the mouth of the tube was excited by specific disease, as small-pox or scarlet fever, and which becoming chronic, had continued many years.

The *Treatment* of the milder degree of Acute Internal Otitis is to be conducted on similar principles, and the remedies are to be the same, as for the more severe form; the activity of procedure being proportionately less, corresponding to the milder form of the disease. Venesection

is too frequently neglected in this affection, for, though it ordinarily occurs in strumous subjects, yet by removing the acute symptoms as quickly as possible, the strength of the individual will be saved, rather than by allowing the disease to progress; this important remedy must, however, be cautiously used; leeching will be very requisite, in almost all cases, with blisters, purgatives, fomentations, &c. The various accessions of inflammation, and its terminations, must be treated accordingly; and especially the Surgeon should ever keep in mind the great predisposition of the malady to assume the severest degree.

With a view to lessen the mucous accumulation, attention should be at first directed to the inflammatory condition of the mucous membrane, which, inasmuch as the symptoms are often very lenient, will be best relieved by a milder course of therapeutics, such as leeching, and particularly blistering, the neighbourhood of the ear and angle of the jaw; improving the secretions, and especially that of the skin, the increased action of which influences so very importantly diseased conditions of the various mucous membranes; fomentations, in the form of warm fluids or vapours, to the fauces, and as far as the patient can admit them without inconvenience, to the mouth of the Eustachian tube itself. When the inflammation has quite subsided, the tympanum may be washed out, and the mucus thus removed, by injections of warm water through the catheter introduced into the tube, or air may be forced in by the same means, and with the same intention; these remedies must not be employed during the slightest inflammatory state, as they would be likely to increase the excitement; unless, indeed, the Surgeon has reason to believe that the inflammation is maintained by the presence of the fluid. The mode of syringing the tympanum will be mentioned when the chronic affections of that cavity are considered.(*a*)

(*a*) The author might have added very properly to these remedial means, the occasional use of emetics, at first to vomit and afterwards to procure nausea. Local stimulants to the mucous membrane of the fauces and pharynx, and, by continuous extension, to the Eustachian tube and membrane of the middle ear,

Section V.

Acute Inflammation of the Labyrinth is still involved in a good deal of mystery, in consequence of the intricacy

might be given with the same view, viz., an expulsion of the mucus of the middle ear through the tube and a removal of the chronic inflammation of the membrane of the tympanic cavity. Enlarged tonsils, especially chronic tonsillitis, will give rise to the disease in question. (See *Yearsley on Deafness from Morbid Condition of the Mucous Membranes, &c., of the Stomach, Throat, Ear*, &c.; also *Stokes and Bell*, Lect. VI., p. 86–88, 2d edit.) After the use of the remedies already indicated, the hydriodate of potassa (iodide of potassium) will be had recourse to with manifest advantage, especially in those cases in which, associated with impeded hearing, are symptoms of depraved digestion and nutrition.

In reference to the production of deafness by enlarged tonsils, Deleau remarks, "that it is rather when these glands are subject to pass the state of acute inflammation, or when they are surrounded by a red and tumefied circle which invades the lateral walls of the pharynx, that hardness of hearing is perceived, or noises in the ear which the patients compare to the boiling of water, or to the rustling of leaves shaken by the wind. A condition still more serious which these glandular bodies take on, is their development from before backwards, so as to separate the pillars of the fauces. Hardness of hearing almost always accompanies flattened glands which tend rather to sink into the flesh than to project into the throat."

In order to prevent a return of *catarrhal* inflammation of the middle ear, Kramer directs that "the patient should persevere for many months, especially if he be of a lax, scrofulous constitution, in a mode of living which not only does not favour the disposition to relapse, to colds, catarrhal affections, and mucous engorgements, but which is strongly opposed to these tendencies. Regular active bodily exercise; washing the neck and upper part of the body with cold water; drinking freely of cold water; early rising; sleeping on a mattress and beneath the blankets; a dry meagre diet, are among the principal things to be attended to, as I have already stated.

"Those patients only, who are of strong constitution, and rather of a spare habit of body, and not the least disposed to mucous engorgements, may return to their ordinary mode of living after the removal of the local affection of the ear: in such persons relapses are rather rare."

and minuteness of structure rendering it extremely difficult to ascertain, upon dissection, organic alterations occasioned by disease; and of the symptoms being obscured by those of other affections of the organ or of the brain; and because Acute Otitis, perhaps, only exists in the labyrinth as an extension from the middle ear, or in connection with such affection. There can, however, exist but little doubt that the membrane which lines the bony labyrinth may be subject to inflammation, although at present *post-mortem* inspections throw but little light upon the subject; and the cases that have been recorded of over-vascularity are certainly too definite to allow any correct conclusions to be deduced. No well authenticated cases are reported of inflammation of the membranous labyrinth; yet it may be imagined that, as it certainly is organized as other structures, it must be influenced by similar diseases. Possibly the thickened condition of one or both of these membranes, which has been seen in old age, may sometimes be the result of inflammation, though generally it occurs as a change merely consequent upon the advanced period of life. Variations have been noticed in the Aqua Labyrinthi, which in some instances may be the result of inflammation; thus the fluid has been observed by Dr. Haighton and Lentin to be turbid, and more dense than ordinary; by Pinel, Itard, and especially by Ribes, it has been found in diminished quantity, so as to be insufficient to fill the canals; whilst other writers have imagined it might be in excess. The nervous expansion itself has been seen to be inordinately vascular, resembling somewhat the retina under a similar condition; but then, as in the case of the retina, much dependence must not be placed upon this circumstance, as the small vessels may have become injected by blood during the dying state. The Auditory Nerve has frequently been seen disorganized, the nervous matter being removed, and the neurilema occupied by fluid; it has been found much harder than natural, as well as much softer, and enlarged; and, again, less than half its size: such variations have been recorded by Haighton, Mondini, Sylvius, and others; and it is probable that sometimes these conditions may occur as different effects of inflam-

mation; though it is certain that in some of the reported cases the defects were congenital; in others the age of the individuals was great, and the deafness but of few years standing; yet in a few it appears that the consequent cophosis came on during middle life, and was, therefore, probably occasioned by acute lesion of the nerve. The existence of acute inflammation of the nervous expansion is rendered probable by its analogy in structure and function to the retina, the inflammation of which is well known to be one cause of Amaurosis; and as extreme intolerance of light, and darting pains through the head, are the chief signs of this affection, so may those cases of intolerance of sound, and similar pains through the brain, with a general state of excitement, be attributable to a similar condition of the nervous membrane of the labyrinth. The Author of this essay is, however, far from wishing it to be understood that he thinks every altered function of a nerve, or its expansion, is the effect of recognizable inflammatory action, as every day's experience clearly proves the contrary.

As so very little is practically known of Otitis of the labyrinth, it would be misplaced to describe at any length what may be the supposed symptoms of such a state, particularly as they may be collected from what must necessarily be observed when we dwell for a short time upon nervous deafness. It may, however, be noticed, that the leading signs of such affection will be a Tinnitus Aurium; an intolerance of sounds, and especially of loud noises; pains in the head, occasionally shooting into the tympanum; general excitement, in some cases amounting to fever. The treatment in such instances must be antiphlogistic, combined with mild sedatives, notwithstanding it is most likely to occur in debilitated persons, and in those whose irritability is great.

Dr. Kramer admits that the labyrinth may be subject to inflammation; yet, as this is in some degree doubtful, he recognizes only the disease of the nervous expansion, *nervous deafness*, which he describes as being of two kinds, *erethitic* or nervous deafness with excitement, and *torpid* nervous deafness: the first may be considered as constituting the acute, and the latter the chronic form. This

arrangement is probably the best that has been yet advanced, and although the erethitic form may sometimes depend upon inflammatory action, yet as it often is of long standing, and assumes more or less a chronic character, it will be perhaps better to treat of the two states, under the general head of Chronic Diseases.

CHAPTER II.

ON THE CHRONIC DISEASES OF THE EAR.

Diseases of the Ear are much more frequently witnessed in the chronic form than in the acute, being either terminations of acute or subacute affections, or originating in the chronic degree. The great majority of cases of deafness result from this form of disease, which in some instances continues during life, producing little more inconvenience than what may arise from the cophosis more or less complete; whilst in others it gradually passes to the structures in the vicinity of its original locality, producing the most extensive disorganization. All cases of chronic disease, particularly of the middle Ear, are predisposed to excitement into the acute form upon the application of suitable local stimulants, or in consequence of a general affection.

It is purposed, in treating of the chronic diseases, as being more convenient, though not strictly in order, to make some observations upon the accidents and injuries to which the different parts of the organ may be liable.

This form of disease of the Ear has been very variously named, and often in consequence of a particular symptom. Dr. Kramer has arranged these affections more philosophically than other Authors, according to the structures affected, as he has endeavoured also to classify the acute diseases; this mode of considering them, although decidedly the best when medical knowledge is so perfect as to enable it to be accomplished correctly, is

not free from objection, inasmuch as several structures may be affected at the same time, the diseased action may pass from one tissue to another, and in many cases the most accurate observation will fail in making the nice discrimination such an arrangement seems to require. And thus if the practice is to be directed by such division, as the symptoms of the supposed different affections run into each other, the Surgeon relying too much upon his theory, may be led into the adoption of unsuccessful treatment. Itard, and after him Andral, and many other authorities, have used the term *Otorrhœa* almost synonymously with chronic Otitis, thus naming the different diseases from a symptom which is very common to them all, namely, a discharge of matter from the meatus; and as this discharge may be either mucus or pus, so the Otorrhœa is divided into *Catarrhal* and *Purulent*. This arrangement, although not so pathological as Kramer's, is more applicable; and if the practitioner regards it in its true light as expressing only a symptom, and takes care to ascertain its cause, it will also become even more practical. But as indeed many chronic affections of the Ear exist, in which there is no discharge, so the term Otorrhœa is inapplicable as a general synonym. In treating this part of the subject, therefore, the name of *Otitis Chronica* will be adopted, which term has been used in a similar manner by Roche. Mr. Curtis appears to designate Otorrhœa to be a puriform discharge from the tympanum; whereas the discharge is quite as frequently the product of a diseased action of the dermal membrane of the meatus auditorius.

Following the arrangement adopted in considering Acute Otitis, the chronic disease as it occurs in the different divisions of the Ear, will be discussed.

Section I.

EXTERNAL CHRONIC OTITIS.

This affection must also be arranged under two heads, that of the Auricle, and that of the Auditory Meatus.

Chronic Inflammation of the Auricle arises from the common causes which excite disease in other parts of the body; but as the auricle is not a very irritable structure, in consequence of the supply of nerves being proportionally less than that of blood-vessels,—which is a very beneficial arrangement, having reference to the function and exposure of this structure;—these causes are not so frequently in operation as might otherwise be expected from its exposed situation; and, therefore, most of the diseases of the auricle extend from the surrounding parts, or are produced by direct injury. Cold, however, does excite disease in this part, and even, as is well known, if the temperature be exceedingly low this structure may be frost-bitten, and may thus be immediately deprived of its vitality, although it more frequently happens that the part is destroyed by the subsequent reaction. Chronic inflammation is also excited by pressure from lying upon the side during the existence of fever, or other general affection, which predisposes to local disease. Such a cause is not at all uncommon; and Boyer mentions the case of a "medical student, compelled by an ulcer on the sacrum to lie for a long time on his side, which occasioning pressure on his ear caused a slough of the anti-helix, and after the separation of the dead part, an aperture, large enough to receive the end of the little finger was left in the pinna."

The foolish practice of ear-boring in irritable subjects is a frequent cause of chronic enlargement of the lobus. Portal has seen this part an inch thick, and notices the prodigious effect produced in a woman by wearing heavy ear-rings, which kept up a constant irritation. Chronic disease of this part of the organ is, however, much more frequently the effect of erysipelas, than of other acute affections. But the disease, when arising in the chronic form, is generally a cutaneous affection, which may commence here, or spread to it from the surrounding parts; hence, it is very common to meet with Erythema of the Auricle, with Herpes, Porrigo, Lepra, Crusta Lactea, Lichen, in fact with all the chronic affections to which the cutaneous system is prone, and which sometimes induce a thickened and enlarged state, continuing after the

original disease has subsided. Such diseases are exceedingly common in children during dentition, and in them they often are pustular, or vesicular. It is very usual, indeed, for these affections of the auricle to accompany strumous ophthalmia, depending upon the same cause, and to be alike removed by means of general remedies, assisted by local treatment. These various forms of chronic inflammation are evidently prone to extend to the auditory canal, and thus they become frequent causes of diseased action in that tube. Encysted and steatomatous tumours, likewise form in the cellular membrane of the auricle, requiring the treatment they receive when in other parts of the body. The Author occasionally sees a lad, who has a small encysted tumour in the concha, which as it does not produce inconvenience is allowed to remain, but could be extirpated without trouble. Mr. Travers removed "the upper third of the external ear, which was the exclusive seat of an indurated sore, having every character of cancer."

The symptoms of common chronic inflammation do not differ from those of the same affection occurring in other organs; the disease is slow in its progress, — pain is but slight, being rather a sensation of itching than actual suffering, — redness not uniform, nor very bright, — heat moderately increased, — tumefaction not at first great, but gradually augmenting. Sometimes it terminates in an inordinate growth, and often in more or less general induration, occasioned by adhesive deposit into the cellular tissue.

The *treatment* must be conducted on the usual allopathic principles; and as it often happens that the local affection is maintained by general derangement of health, an improvement of the state of the constitution will require the first attention. The ulcer, or hardened and thickened condition which may result, will require the ordinary applications; in the latter state Iodine will often be found a very useful local remedy.

§ *Chronic Inflammation of the Meatus Auditorius Externus*, presents a variety of symptoms, depending upon the cause, and the structures involved in the disease. The

chronic affection of this tube is a frequent cause of Otorrhæa giving rise to dulness of hearing, yet it is by no means the only one. It is much to be regretted that either in consequence of the due investigation of the tympanum being attended with some degree of difficulty, or from the general inattention which has prevailed as regards aural surgery, practitioners have for a long while directed their applications solely to the external tube; and it is much to be feared have, by their too often empirical treatment, increased the disease, and expedited its extension onwards to the tympanal membrane and cavity. As these diseases are somewhat various, it may render the history of them clearer and more simple, to describe them under different sections, and as far as the Author's experience will permit, in the order in which they more frequently are met with in practice.

1. *Erythematic* chronic disease of the meatus. The Writer uses this term, perhaps incorrectly, to denote a frequent affection, described by Roche under the name of *l'Otite Chronique Seche.* In this disease the general health is usually impaired, though ordinarily without any serious malady being apparent, — there is uneasiness in the auditory canal, — sometimes slight pain, — returning at intervals, with an itching dry sensation, — occasionally attended by heat,— there is also difficulty of hearing, and not unfrequently some tinnitus aurium; but in general no further inconvenience is experienced than what arises from the deafness, and from the uncomfortable sensations occurring in the canal. The tube upon inspection is found to be unusually dry, and if the wax be formed at all, it is in very small quantity; but most frequently there is a vitiated secretion of a white or yellowish scaly matter, which lines the tube more or less extensively, generally formed into small patches, though sometimes occupying the whole length of the canal; this morbid matter is easily separated from the surface, but usually remains in the tube unless artificially removed, This secretion is the product of the ceruminous follicles, and is probably the wax mixed with abnormal constituents, quickly converted by evaporation into this peculiar matter. The mucous, or dermal lining of the tube, pre-

sents a rosy appearance in certain points, which in more extensive cases occupies its entire length. A similar vitiated secretion, solidified by inspissation, has been found covering the surface of the tympanal membrane, either secreted from its outer face, or extending over it from the canal; the former is the more probable supposition, as this deposit has been occasionally seen upon the membrane, when the accumulation has been so slight in the tube as hardly to justify the belief that it could be derived from that source.

This abnormal product is a very common affection, and becomes the cause of dulness of hearing more frequently than is perhaps imagined; and although it generally exists without any other affection of the aural organ, yet it not unfrequently accompanies a deficient sensibility of the acoustic nerve. As such a secretion is very frequently removed from the meatus of young subjects which are submitted to anatomical dissection, it is very likely that it may arise from the diminished energy of the dermal membrane during the illness which terminated fatally; and it is also further probable that in many other instances lessened powers of secretion may produce this mal-constituted matter instead of healthy cerumen, and that its presence may be the cause of the slight inflammation noticed. Though this may be a probable cause, no doubt exists in the Writer's mind that it is usually the product of a chronic inflammation of a peculiar or erythematic modification.

The author remembers a lady who was in delicate health, and had borne several children within a short period, who suffered considerable annoyance for many years from the affection under notice; it was much increased by the slightest general excitement, yet gave rise to but little alteration in hearing. The disease was benefited by such remedies as amended the health, and by the application of astringents.

A child who had been deaf for some months, heard almost perfectly well, immediately upon the Surgeon removing a thick, white, toughish scaly matter from the surface of the membrane of the tympanum.

The late Mr. Earle has detailed several cases of this

affection in the tenth volume of the *Medico-Chirurgical Transactions*, and as one is an aggravated example, the heads of the history may be related: —

"In 1816, Mr. F., an ensign, gave this account of his Ears; from childhood he had been occasionally liable to attacks of inflammation in the external Ear, accompanied with heat, excoriation, and a copious thin discharge from the passage, which affected his hearing, more or less, for several weeks, but left no considerable permanent deafness behind. About ten months before his application, he had been exposed to damp, and, in consequence, suffered a severe renewal of the same disease, which so nearly deprived him of the power of hearing, as to oblige him to leave his regiment, in pursuit of further advice, with an understanding, that unless he could obtain some relief, it would be necessary for him to quit the service, as he was quite incapacitated from active duty, by not being able to hear the word of command. On examination, I found the meatus of either Ear much narrowed in its calibre, by the thickening of the surrounding parts, and especially the great increased density of the cuticle, which had a very white appearance, and was moistened by a thin discharge, resembling runnet-whey, that deposited a substance not unlike small portions of curd. On washing this away, and dilating the passage, there was not the slightest appearance of cerumen; but the same white thickened cuticle appeared to extend as far as the eye could reach. The sense of hearing was nearly lost, but a watch applied to the teeth or forehead was distinctly audible. On injecting water, a dull obtuse sound was produced, as if some dense medium were interposed; and by passing a probe to the bottom of the meatus, a sensation to my touch was conveyed, different from that which would have been produced by the contact of a healthy membrane; whilst at the same time it did not cause the usual painful sensation. These circumstances led me to imagine that it was possible that the deafness depended either on a thickened state of the cuticle reflected over the membrana tympani, similar to that which lined the meatus, or on some morbid secretion existing

between this cuticular layer and the membrane. To effect the removal of this cuticular lining, I had recourse to the nitrate of silver; and threw in, with a silver syringe, a very strong solution, which completely blackened the epidermis of the meatus. In a few days, upon syringing with warm water for a considerable time each day, the exfoliations were detached, in small portions at first, but subsequently in longer pieces, one of which, from its form, was very evidently the reflected layer which had covered the membrana tympani. The next syringeful occasioned a very distressing sensation and loud sound. His hearing from this time was greatly improved, but still rather confused. The other Ear was treated in the same way with similar success. In a few days the hearing was very nearly restored. After the separation of the cuticle, the treatment consisted in the application of *Ungt. Hydrarg. Nitratis*, dr. iv., *Cerati Cetacei*, dr. iij., *Olei Olivæ*, dr. i.; which was introduced night and morning, with a view to stimulate the ceruminous glands; blisters were used with the same view. Soon afterwards he returned to his regiment, and continued quite well; the healthy secretion having returned."

The author has quoted this case at greater length than he intended, for although Mr. Earle describes the morbid product, as consisting of thickened cuticle, and seems to imagine that it resembles the covering found on the feet from pressure,— he feels satisfied it is an excellent, though aggravated example of the erythematic chronic inflammation long neglected.

In the same paper Mr. Earle alludes to two cases, in which this white scaly matter was mixed with cerumen, and nearly closed the meatus. One was relieved by the improvement of the health, and the use of a combination of the ointments of zinc and nitrate of mercury. The other was neglected.

The *treatment* of this form of chronic external otitis, will not materially differ from that of other varieties of the affection. The amendment of the general health is of the first importance, and this is ordinarily best effected by mild alteratives, and the remedies usually denomi-

nated tonics, of which sarsaparilla has been held in great estimation; change of air; warm sea-bathing, &c., are all beneficial adjuncts. When the actions of the vegetative organs, among which the secretions form so important a class, are improved, local remedies will in most instances be attended with happy results, and the more so in proportion to the early treatment of the case. It will rarely happen that the symptoms of inflammation are sufficiently high to justify the use of leeches; but blisters behind the auricle possess the beneficial advantage of derivatives, when the action of the membrane of the meatus is increased; and of excitants when the action is diminished. Experience teaches us, that the best applications are astringents, and of these the nitrate of silver in solution is usually the most efficacious, in strength varying from two grains, even to a scruple or more, to an ounce of distilled water; the sulphate or acetate of zinc, the salts of copper, and of alum, are very valuable applications. Previously to their use, it is requisite to well syringe the meatus, and to remove as much of the inspissated matter as possible. The strength of the solution should accord with the excitability of the meatus, and, indeed, also with that of the individual; and particularly with the extent of morbid secretion. In some cases of extreme thickness of deposit, the nitrate of silver may be advantageously applied in substance, by cautiously introducing the stick into the canal, as the artificial covering will protect the lining membrane from injury. Stimulating ointments are also found of marked benefit, as those of the nitrate of mercury, of the oxyde of zinc, &c., sufficiently diluted, introduced twice a day upon a camel's hair pencil-brush, as far into the meatus as the disease extends, and even, if requisite, upon the surface of the membrane itself.

2. Chronic Inflammation of the Dermal Membrane, with *inordinate Secretion:* this is the "Humid Chronic External Otitis" of Roche; the "Mucous or Catarrhal Otorrhæa" of Itard and Andral: as the latter denomination includes a very important symptom, it may be considered as an appropriate term. This affection is very common, and is that which, without doubt, most fre-

quently occurs in children; in whom it is often excited by the irritation produced by dentition. The disease may be the consequence of acute inflammation; and very frequently is the result of an injury occasioned by a foreign body, arising either during its presence, or after its removal. The same causes that produce acute inflammation, will likewise occasion at once the chronic form; and the spreading of exanthematous diseases must be reckoned as one of the most frequent excitants. It is also described by Itard in particular, as well as by other writers, as arising from metastasis, as from gout, gonorrhœa, mucous ophthalmia, &c. Scrofulous individuals are particularly predisposed to this form of disease; which is the reason, in addition to the accumulation of dirt in the meatus, that it so very constantly presents itself in the poor children of crowded localities.

The *symptoms* are generally very mild, and hence the affection is so often neglected; there is some uneasiness in the Ear, rarely amounting to pain, and after the disease has existed for a few weeks even that unpleasantness subsides: the part appears to be hardly increased in temperature. The hearing is a little diminished, more particularly at the commencement of the malady; but if the tube be not contracted by morbid vegetations, this effect is often but slight. The discharge, which is generally profuse, is at first smaller in quantity than subsequently; variation in this respect occurs from time to time, usually in consequence of an apparent increase of inflammation, but often without any evident cause. The matter likewise changes its character, presenting at differ times various shades of colour, odour, and consistence; at one time being serous, at another mucous, and then puriform, or these different appearances may be variously combined; occasionally little white patches are mixed with the fluid, which frequently adhere slightly to the surfaces; these incrustations occasionally consist of fibrin, though more generally of inspissated mucus. The variations indicate the varying degrees of inflammatory action at the different periods.

The lining membrane of the auditory canal is sometimes but little altered from its natural condition; gene-

rally, however, presenting the appearance of chronic inflammation, it is reddened, irregularly tumefied, and, when the disease has existed for some time, it even becomes spongy or rather villous; the surface is often covered with numerous little granulations or vegetations, varying in size and number, and of a reddish colour, from which the matter appears to be secreted; some of these are new growths, though probably the bulk of them are enlarged ceruminous glands. It not unfrequently happens that Fungi or Polypi are consequences of this affection, which, partially or completely obliterating the tube, occasion more or less deafness: sometimes such formations are attached to the whole circumference, but in general to one face only of the canal. Now and then the disease gives rise to chronic ulcers, which may extend to the cartilage, or even through it, though they are usually confined to the thickened mucous membrane. This affection, which often continues for months, sometimes even for years, and occasionally during the person's life, is for the most part unconnected with disease of the tympanum, although such complication is by no means rare, as this important cavity is liable to be involved in consequence either of the extension of the chronic inflammation, or of the matter, not being freely discharged, and lying in contact with the membrana tympani, exciting in that structure chronic disease, which generally leads to ulceration.

Acute Inflammation, taking the course already described, may supervene upon the chronic condition. The frequent occurrence of this disease renders it unnecessary to report any cases.

The *Treatment* is that which is adapted to other chronic affections, and should be conducted in the mode already described when speaking of the Erythematic inflammation. The improvement of the general health is of the first moment. The cause of the disease should be sought for, and if possible removed; thus the division of the gum, if dentition be the excitement, will be absolutely required; if the presence of a foreign body in the meatus be suspected, the canal should be carefully examined, with a view to the removal of the irritant; the

neglect of this precaution has allowed a disease to become persistent, which otherwise might have been removed in a few hours. Leeches will only be requisite when the complaint is exasperated, which may be the case in consequence of a too stimulating regimen: blisters and other counter-irritants, as issues and setons, are most valuable remedies: as local applications, the astringent lotions are chiefly to be depended upon; and of these the solutions of alum, of zinc, of lead, and of the nitrate of silver, in the proportion of from one to three or five grains to an ounce of distilled water, must hold the first rank in the scale of utility. Kramer recommends, in the spongy condition of the chronically diseased meatus, tents of fine soft lint dipped in a solution of the acetate of lead, introduced into the tube, the pressure of which is eminently useful. It has been noticed that the discharge sometimes subsides upon the occurrence of disease in another organ; as for example, the enlargement of the neighbouring absorbent glands, inflammation of the eyes, or skin, or even it is said of the testicles; a similar result may be the consequence of an affection of the brain, which affection may indeed be consecutive upon the Otorrhæa. It is of the highest importance that the attention of practitioners should be directed to the fact, that serious mischief has not unfrequently been induced in the brain by the injudicious employment of irritating injections: these applications, at the same time that they arrest the secretion, may excite so much inflammation that it readily spreads to the surrounding predisposed structures; the mere cessation of the discharge even may produce a vicarious increased action in the cerebral membranes, without an accession of Otitis. Much caution is therefore required in the administration of local astringents; and it is better first to employ the mildest, as even warm water or milk, and gradually to use the more powerful according to the effects produced. Itard seems to carry his fears rather to an extreme in these cases; yet, when the tympanal cavity is involved, his caution is quite justifiable. This aural pathologist, to whom mankind are so much indebted, guards us against the use of oily injections, as they are apt to become rancid in the ear, and to block up the dis-

charge; he mentions a case of a child, in whom Otorrhæa was suddenly suppressed by an injection of linseed oil, and who was seized with convulsions, which quickly terminated fatally: in all probability, in this instance, the cavity of the tympanum was diseased, and in part furnishing the secretion. It has long been a fashion in this country to apply ox-gall mixed with oil of almonds, to the chronically secreting meatus, as a stimulant and lubricant combined. The tincture of castor is another remedy which has been vaunted, perhaps without any just grounds; but the empirical employment of such applications urgently calls for condemnation, especially when, as in such circumstances so frequently happens, the condition of the tympanum is altogether overlooked by the prescriber. It will be necessary for the Surgeon to ascertain if the escape of the matter be prevented by an inspissated substance, or perhaps by bone, if exfoliation be occurring, in order to remove the obstruction.

3. *Polypus*, *Fungus*, or *Vegetation* of the Auditory Canal is an exceedingly common occurrence. These terms are very frequently used synonymously; but probably it would further pathological distinctions if they were better defined. The Term *Polypus* (though its etymology means many footed) is ordinarily applied to a growth from a particular spot of a mucous membrane, the rest of the membrane being healthy, or at all events not implicated in that growth. This morbid production has usually one pedicle, but there may be several such attachments: its vascularity varies, occasionally a single artery runs down the centre, while in other cases the whole polypus resembles a congeries of blood-vessels. *Fungus* is usually intended to imply a diseased growth, arising from a membrane more extensively disorganized and frequently proceeding from an ulcer or a sinus; it consists of a mass of exuberant granulations, always soft and vascular, but, as there is usually a want of power in the circulation, the colour is generally of a palish-red hue. The fungus, unlike the polypus, is not uniform in its shape, but irregular, both as regards its extent of attachment to the diseased membrane, and as respects the division of its loose extremity into lobules. There is always a dis-

charge of matter, either mucous, purulent, or muco-purulent. The term *Vegetation* is most frequently applied to numerous little diseased growths from a more or less extensive surface of a mucous membrane; they are sometimes soft and fungoid, with narrow attachments; at other times firm, and conical; the degree of vascularity varies; and the vessels always secrete a fluid, though not so copiously as in the fungus. This species of morbid excrescence appears to consist in some instances of enlarged follicles, in others of organized deposits in the membrane and the sub-mucous tissue, and occasionally of little fungi.

Such are the different appearances these growths assume in the external ear in particular, as well as in other parts of the body. The *Polypus* of the meatus is generally red and vascular, and if secreting at all, it is in a very limited degree; it often arises without evident cause, yet is frequently the consequence of some local irritant, as a foreign body, or injury of the lining membrane by the ear-picker. The body, usually attached by a single root, is oval or round, and generally regular. It often acquires a moderate size before the patient is aware of its existence, and his attention is at length drawn to it by a slight and increasing difficulty of hearing, depending upon the obstruction produced by the polypus — by a little uneasiness occasioned by its pressure — by a discharge from the ear in consequence of a cold — and by the bleeding, which arises when the finger or other substance is introduced into the canal. When large enough to occupy the whole calibre of the meatus, the tumour occasions deafness, the cause of which is, of course, immediately apparent upon examining the ear. A polypus may proceed from any part of the auditory tube, and likewise from the surface of the membrana tympani. The accompanying drawing (Plate XIII.) is a faithful representation of Mr. Martin's ear, and affords an excellent example of the usual character of this growth; the polypus is attached to the anterior wall of the canal by a single pedicle, and might be most easily removed, by which, no doubt, his deafness would be relieved.

The polypus does not always present the highly vas-

cular appearance, but when, as in the following case, it consists of a very considerable elongation of fungoid granulations, the enlarged extremity is often supplied with blood only sufficient to maintain its existence; and even that sometimes fails when the growth of the tumour is still more extensive in proportion to its nourishment.

Mr. G. W., aged seventeen. — At two years old was affected with scarlet fever, in consequence of which disease his life was despaired of for a month or six weeks, and he continued indisposed for three months, during which time the glands at the angle of the jaw (tonsils ?) suppurated, and were lanced about two months after the attack. During the progress of the disease he became deaf, and had a copious discharge from both ears, which has continued ever since from the right ear, and until within two years from the left. About two years ago a tumour was noticed in the right ear, which has slightly enlarged. A similar growth occurred in the left ear, but smaller, ' which burst and went away.'

August 15th, 1838. — Upon inspection of the right ear, the Author found a polypus, nearly colourless, with a few minute vessels ramifying in it, the head about half a square inch in extent, projecting beyond the meatus, and attached to the parietes of the canal by a narrow and long pedicle (which it is possible might have reached backwards to the membrana tympani). Upon moving the body to one side, very vascular fungi were seen to occupy the whole calibre of the meatus, from the middle of the canal backwards, and which surrounded the attachment of the polypus. A very copious and offensive discharge was furnished by these fungi. Upon passing the probe inwards beyond these growths, it appeared to strike against the bony wall of the tympanum; the probability, therefore, is great, that they proceed, in part at least, from that cavity. The meatus of the left ear contained a large quantity of inspissated muco-purulent matter, upon the removal of which it was seen that fleshy vascular vegetations occupied the bottom of the meatus, completely obliterating the membrane; the condition of which it is at present impossible to ascertain. Both the Eustachian

tubes were healthy. The patient is deaf to a degree to interfere with his occupations, but can hear a little better on the left side than on the right.

The Author extirpated the polypus with the scissors, as far as the fungus, and has since touched the diseased growths with the lunar caustic every day. They are diminishing in size, and the discharge is much lessened, with a corresponding improvement in hearing.

The *treatment* consists in removing the body; and when it is attached to the wall of the meatus, and can be reached by the knife or scissors, excision will be the readiest and most efficacious mode of extirpation; the hemorrhage, may be arrested, if necessary, by the nitrate of silver, any mineral acid, or the muriate of barytes introduced on a probe, or indeed by any approved styptic, or by pressure carefully made with layers of lint, or a piece of sponge; and the same remedies occasionally used will prevent its recurrence. A ligature may be also sometimes, though generally with difficulty, passed round the morbid growth; if the ligature be of silk it may be applied with the aid of an eye-probe, or if it be silver wire conducted by means of a small double canula, and tightened from day to day, until the tumour drops off. If the whole attachment of the polypus cannot be encompassed, the judicious Surgeon not knowing its extent will proceed with great caution in the removal, as it is probable that the tympanal membrane may be implicated in the disease. The polypus may also be twisted off, with a pair of well grasping forceps, either partially or entirely; if the former takes place the operation must be repeated, and escharotics applied to the lacerated surface. These modes of treatment are not free from danger, when the membrane of the tympanum is diseased, and especially when the cavity is exposed; as the predisposition to inflammation is then much increased, and the tumour may proceed from the tympanal lining. A polypus growing from the surface of the membrana tympani will not admit of removal, unless it projects so far outwards, and the meatus is sufficiently capacious, to allow a small curved knife or scissors to be passed to its pedicle, which is not

very probable; the practitioner will in that case be obliged to depend upon the careful use of escharotics.

The *Fungoid Excrescence* is by far the most common growth from the surface of the meatus, and is very usually met with in long continued otorrhæa of this canal. In some cases the tumour is merely a hypertrophy of the mucous membrane, but in most instances it is a diseased exuberance, consisting occasionally of morbid granulations from an ulcer or sinus, in the latter case being projected through the opening, the excrescence becomes much expanded.

The fungus presents the appearance already described, being generally irregularly divided into different portions at its summit, and has more or less extensive attachments to the parietes of the canal. A secretion, varying in quantity and quality, is always afforded from the surface, and which covering the excrescence requires removal by syringing for the purpose of examination. The growth, though it general proceeds according to the Writer's experience, from the posterior wall, occasionally occupies the entire tube, but it is probable in such a case that the attachment is limited to a part of the lining membrane; it may also be formed from the surface of the membrana tympani. This fungus is sometimes the cause of the continued Otorrhæa, the whole discharge being formed from it, though generally the rest of the lining assists in the

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PLATE XIII.

Fig. 1. — The caseous tumour of Emily Jefford's ear.
Fig. 2. — Polypus of Mr. Martin's ear.
Fig. 3. — The Polypus in Mr. W.'s ear, as it appeared by merely dilating the Meatus.
Fig. 4. — The Polypus in Mr. W.'s ear, held on one side to expose the fungus surrounding its pedicle.
Fig. 5. — Fungus in Young's ear, partly attached to the Membrane of the Tympanum.
Fig. 6. — Mr. Davis' ear, with the Fungus growing from the upper wall of the Meatus, and from the Membrane of the Tympanum.

Plate 13.

Fig. 1

Fig. 2

Fig. 3.

Fig. 4

Fig 5.

Fig. 6.

secretion. From among many instances the following may be mentioned as illustrations: —

Martha Price, aged thirty-three, had a dulness of hearing for two years: last August she experienced pain in the ear and side of the head; eleven weeks afterwards a puriform discharge took place from the ear, upon which the pain ceased, On examination it was found that an abscess had formed behind the cartilaginous portion of the meatus, and had ulcerated into the canal, from which a fungus had formed, giving rise to a chronic discharge. Her health was improved, and the application of a solution of nitrate of silver two or three times a day, was attended with a removal of the excrescence, and consequent cure of the Otorrhæa and deafness.

"Mr. Thomas Davies, ætat. thirty-five. — At six years old had scarlet fever, soon after his recovery from which, a discharge appeared from both ears, for which various applications were made without any good effect. For some years no inconvenience beyond the discharge was experienced, when he felt something in his ear, which upon examination proved to be a polypus (query fungus?). He was under the treatment of Mr. Curtis for some time, and was blistered, &c., without advantage. The disease was then neglected for fourteen or fifteen years, the polypus (?) during that period having increased in size so as to occupy the whole cavity of the external ear. Mr. Maule then removed a considerable portion of it by twisting it off with the forceps; this operation was several times repeated, and always with considerable pain, and with an improvement of hearing corresponding to the quantity removed." Upon recent examination the Writer found a large fungus occupying the bottom of the canal, and completely obscuring the tympanal membrane, from which a copious discharge was proceeding; upon sounding the membrane, by passing the probe beyond the tumour, that portion presented a healthy feel. The Eustachian tube was partially closed, and the membrane of the tympanum on the opposite side was perforated. The patient has long declined further treatment than syringing with warm water (Plate XIII.).

Upon examining the ears of Edward Young, who says he became deaf, in consequence of the violent noise of a cannonade while serving in Egypt, about twenty years ago, the Author found a large fungus growing from the posterior wall of the meatus, which appeared to be also attached to the membrane of the tympanum, and a great quantity of matter was secreted from its surface. This patient has not yet submitted to treatment, in consequence of labouring under another affection (Plate XIII.).

The removal of a fungus is not usually so successful as the extirpation of a polypus, for in consequence of the diseased state of the dermal membrane the growth is very likely to return; it may, however, be extirpated, either by the knife, by twisting it off with the forceps, or in some rare instances by the ligature. A rigid after-treatment will be required, which must be directed also to the entire tube. The fungus is more easily controlled than the polypus by escharotics; the Author remembers to have removed such a growth from a young lady's ear in about a fortnight, by applying to it a few drops of the muriate of barytes upon a probe two or three times a week; among the most valuable of these remedies, the *argenti nitras* in substance or solution, and the *alumen exsiccatum* in powder hold the highest rank.

The numerous little *Vegetations* of the lining of the external meatus, which are the product of chronic inflammation, are an occasional cause of Otorrhœa; they assume the character above described, and are usually, when firm, attendant upon a general thickening of the mucous or dermal membrane. These growths may be, in most instances, checked or removed by astringents, and particularly by the nitrate of silver. Kramer speaks highly of the use of a solution of the acetate of lead in these cases, and alludes to an instance in which "a stalactite-shaped growth hung from the superior surface of the meatus, very near to the membrana tympani, of so remarkable a bony hardness and density that it was impossible to pierce it with the sharpest knife. Yet an important improvement in the hearing distance was effected by the application of acetate of lead in solution."

Tumours of various kinds, either congenital or arising after birth, are also found in the meatus, they occasion deafness by mechanical obstruction, and require removal in the manner already indicated. As an example:—

The Ear of Emily Jefford, aged two years, is delineated (Plate XIII.), the tumour was congenital and consisted of caseous matter contained in a cyst; as it was impracticable to surround it with a ligature in consequence of the large size of the base, the Author removed it with the scissors; the slight hemorrhage was readily arrested by the introduction of a piece of sponge.

Mr. Grantham has lately reported in the *Medical Gazette* the case of —

"Thomas Middleton, aged forty-five years, who applied to him in consequence of complete deafness of the right ear, which, on examination, he found to be caused by an osseous tumour growing from the upper and back part of the meatus auditorius, extending across and filling up the passage so as to interrupt the ingress of sound. He broke off the tumour, which was attached to the meatus by means of a narrowed peduncle, with a strong pair of dissecting forceps. The patient compared the separation of the tumour to the firing of a large cannon close to the head. The hearing gradually became restored."

4. The *Sinus*, to which allusion has several times been made, usually occurs in consequence of an abscess external to the meatus, having ulcerated through the cartilage; the aperture maintained by the constant discharge through it, at last becomes callous. The sinus occasionally extends outwards from an ulcer of the meatus, and may or may not be attended with fungoid granulations. Sometimes there is likewise an external opening behind the outer ear, and occasionally a communication with a diseased mastoid process. The external table of which portion of bone only may be carious or exfoliating; or the sinus may open into the cells, thus obtaining an indirect communication with the tympanum; in these

instances osseous spiculæ may be discharged through the meatus, by which the inflammatory action is maintained, and occasionally increased.

If the sinus be nearly superficial, and the meatus otherwise healthy, by cauterising or destroying by some other means the margin of the ulcer, the inflammation which succeeds may produce granulations, and a cure may by these means be effected. Stimulants are used for this purpose, and with occasional success, though it must be admitted, they are very often unattended with a beneficial effect. If a more convenient opening can be made externally it should not be neglected, but in general the aperture in the canal is less troublesome than it would be if placed between the Ear and mastoid portion. When the mastoid bone is diseased and exfoliating, and even when the ulcer discharges abundantly, it may still be necessary to make a sufficiently free opening over its site to allow the ready escape of the matter and the sequestrum, by which means the ear may be saved from considerable danger. In many instances the sinus will continue during life, and the repeated attempts to close it are attended with dangerous excitement.

5. *An inordinate Ceruminous Secretion*, is very frequently a consequence of acute, or rather subacute inflammation of the meatus, which terminates by inducing a preternatural increase of the normal action. Dr. Kramer has described this affection as following erysipelatous inflammation, but he appears to apply to that term a signification different to that which is adopted in this country. It is not sufficiently understood, that this very common accumulation is generally the effect of increased action, a circumstance which becomes apparent to the careful observer, although as the inflammatory action is considerably diminished by the increased secretion, the true nature of the affection often escapes detection. The cerumen being thus formed in large quantity, becomes inspissated by the evaporation, and perhaps partly by the absorption, of its fluid particles, and then produces a mechanical obstruction to hearing; in some instances, acting as a foreign irritant, it excites disease, generally chronic, but occasionally acute. When arising from in-

creased action, the superabundant wax is often unusually fluid, and readily flows out of the meatus. This inordinate secretion is occasioned by exposure to cold air, frequently by dirt collected in the meatus; hence it is often met with in uncleanly persons, and it may arise from any slight exciting cause. Wax is frequently combined with the mucus of chronic Otorrhæa, and sometimes, in the early or the latter stages, when the inflammation is moderate, with the discharge of acute catarrhal Otitis. Such an inspissation of wax is a very common effect of the diminished energy of secretion in old age, at which period it seems natural that a change should occur in the action of the various organs, and in that of the mucous membranes among the rest, in consequence of which not only is the quantity lessened, but the relative constituents of the cerumen are altered; it is darker, more dense, and consequently more readily condensed into a hardened mass; and the hairs in the meatus, being now thicker and stronger, by preventing the discharge, will facilitate the accumulation. Such a condition of the lining of the meatus occasionally occurs also in young persons, in whom, without any inflammatory action, the secretion becomes changed from the perfectly normal state, and quickly inspissates, though at this age the torpid action is more frequently the result of previous excitement.

When it arises from inflammation, the *symptoms* will depend upon the extent of increased action; if it should be subacute, there will be some itching uneasiness, sometimes amounting to pain, accompanied by a discharge of the wax mixed with mucus; if it be chronic, the unpleasant feeling is very slight, sometimes not existing, and the attention is directed to the affection only by the dryness of the tube and dulness of hearing. When the induration of wax depends upon a deficient action, the hearing becomes gradually impaired, and it is highly important to attend to the fact, that this diminution of hearing is often erroneously attributed to decreased nervous power, a mistake the more liable to arise, inasmuch as the affection is generally accompanied by a singing noise in the ears. If the real cause be not ascertained, the cerumen

becomes at last almost of a stony hardness; and as it gravitates to the bottom of the canal, and lies against the membrana tympani, it often becomes moulded to that surface, and complete deafness is consequently the result. Sometimes the wax, becoming viscid and irritating, gives rise to an Otorrhæa, which will continue so long as the exciting cause remains. It is therefore very requisite that in every affection the canal should be very carefully examined; as the disease will baffle every other treatment than the removal of the accumulation by syringing with warm water. Dr. Kramer and all other authors mention several cases of chronic disease of the meatus, which had been treated in vain for months, and often for years, when a careful examination detected a hardened lump of wax lying against the membrane, the removal of which was instantly successful in restoring hearing. The ear-picker, often introduced by the patient to remove some titillation, only scrapes off a little of the surface, and the patient may imagine he has removed the whole.

A medical friend has furnished the Author with the following interesting history of his brother's case: —

"Mr. M. was afflicted with deafness on one side for upwards of sixteen years; he applied to several medical gentlemen in York, Hull, &c.; blisters were applied; different lotions were dropped into the ear, which was also syringed, but he found no relief. About 1825 he applied to Sir A. Cooper, who gave it as his opinion that a small tumour or abscess was forming; he returned to the country, and enjoyed good health, until being thrown out of his gig, when his faculties became impaired from the injuries he then received. He was advised to return to London, and take the opinion of Dr. Armstrong, which he did without benefit. He then went to Amsterdam, and took frequent warm baths for the sake of his general health. Having remained one day in the bath for a considerable time, he heard a sudden report, and fancied some one had shot him; and, on looking about, he found what appeared at first to be some hard missile, about the size of a pea, floating upon the surface of the

water; but on further examination at home, it proved to be a lump of extremely hardened wax: he heard distinctly from that time until his death."

This case is interesting, by showing how acute observers, by not being accustomed to examine the meatus, may overlook a very simple cause of disease, and how completely the patient's prospects may be marred by this apparently trifling circumstance, as this gentleman had been obliged to resign a lucrative business in consequence of his deafness. Of course the frequent bathing had loosened the wax, and then, upon its escape, the sudden restoration of hearing occasioned a noise which was alarming.

The Writer removed from the opposite ear of Edward Young, to whose fungus allusion has been made, a lump of wax, which had been accumulating for many years, and occasioned deafness.

A medical gentleman had been hard of hearing for some years, with ringing noises in the ears, a dryness of the meatus, and slight uncomfortable sensations occasionally in the head; thus the symptoms simulated those of nervous affection. His ears had been frequently syringed by his professional friends, without the removal of any wax, or benefit to the function. In consequence of an unusual narrowness and obliquity of the auditory canal, it was impossible to obtain a view of the whole extent of the tube; but by sounding with a probe, the Author discovered that both meatus were plugged with hardened cerumen, the induration being greater on one side than the other. The wax was removed by diligent syringing, with a perfect restoration of hearing.

The *treatment* of this affection is very simple, it consists in allaying any inflammation which may exist; and in removing the cerumen, whether it be hardened or otherwise; when soft, there will be no difficulty in washing it away, which will be the chief means of abating the accompanying irritation. When the wax is extremely in-

spissated, sometimes amounting almost to a rocky consistence, its removal is often difficult, yet experience seems to prove that it may always be accomplished by assiduous syringing. In order to operate effectually, the syringe should be larger and more powerful than that ordinarily used; and as those made of brass are more true than others, they are best adapted for the purpose. The ear-syringe of the London instrument makers is a very excellent instrument. The auricle is to be drawn upwards and backwards, to lessen the obliquity of the canal; the pipe of the syringe to be introduced as far as can be done without pressing upon the surface of the meatus; and a full and long stream of warm water is then to be thrown along, first one surface, then another, of the tube, so that the fluid may be insinuated all round the cerumen: the convenience of the basin used will be much increased if that side towards the patient be flat, with a concave margin. The Surgeon will first ascertain that the tympanal membrane is perfect, otherwise the fluid forcibly thrown into the cavity may there excite inflammation. In ordinary cases there is no fear of the water not returning, and very little indeed of injuring the meatus of the membrane. While the hard wax remains in the canal, rather a pleasant sensation, with a humming noise, is occasioned by the syringing, but when the tube is clear, the blow produced upon the membrane is sometimes very painful and stunning. The operation should be continued for half an hour every day till it is successful, unless this be forbidden by the irritability of the part. The dislodgment may generally be assisted by the previous introduction of a few drops of warm oil, either of olives or of almonds, which will lubricate the surface, and may thus loosen the indurated wax. Fluids variously medicated have been used for the purpose of syringing; some of them have possessed a certain degree of fame, but as the Author's agrees with the much more extensive experience of Dr. Kramer, that warm water answers the purpose as well as any other fluid, and is less likely to stimulate, further notice of them is not required: many practitioners, however, prefer soap and water, and some milk and water, for this purpose. When the cause has been removed, it is often necessary

to restore the lining membrane to a healthy action, by the application of some gentle stimulant, either in the form of a lotion or an ointment, and perhaps the diluted ointment of the nitrate of mercury will answer the purpose better than most other remedies.

A caution against empirical syringing may here be permitted, as it has frequently happened that water forcibly thrown against the membrane, when unproteced by wax or a foreign body, has produced injurious effects, which have been more or less lasting. The practice should also be conducted with the greatest care, when the membrane is known to be ulcerated, or when such a condition is only suspected. The unscientific employment of this frequently valuable remedy has often excited acute disease in a predisposed tympanum, and has even induced fatal consequences.

6. *Aphthæ* or *Herpetic Ulcerations* occur in the lining membrane of the auditory meatus; they are usually the consequence of an extension of disease from the auricle and neighbourhood, though frequently confined to the tube alone; and are accompanied by chronic inflammation more or less extensive, which is generally limited to the circumference of each little ulcer. There is often interstitial effusion, producing a tumefaction of the membrane, which if much injected with blood-vessels, presents a spongy character; and so great is this distension of the membrane in some instances, as to obliterate the tube. There always exists a discharge of a thin, often ichorous, matter, sometimes bloody, with uneasiness or pain corresponding to the inflammation; the hearing is impaired, and suspended in urgent cases, when the tumefaction is very great. This affection, like the other varieties, may continue for many months or even years, with variable severity; and, as in many instances, it also affects the surface of the tympanal membrane, the disease under the state of great excitement, is in danger of extending to the cavity of the tympanum.

The *Treatment* should resemble that for chronic inflammation of the meatus; thus the general health, the faulty state of which is the chief cause of the disease, should be improved: the use of alterative astringent in-

jections is requisite; and with this view the surface may be painted with the black or yellow wash, or with the solution of lunar caustic; counter-irritants are also of great benefit.

7. In consequence of long continued chronic inflammation, or as a sequela of the acute disease, the cartilage, or the bone of the auditory canal, occasionally *exfoliates*. In this case the mischief ordinarily extends to the surrounding structures, and the portion of dead cartilage or bone may escape either into the meatus, or through an ulcer external to it. It is, however, generally complicated with an affection of the mastoid process, or of the tympanum. This form of disease is to be treated on general principles, care being taking to form, when practicable, a sufficient external outlet for the escape of the bone or cartilage. It is unnecessary here to observe how much more predisposed, from its structure, the bone is to exfoliate than the cartilage, which, on the contrary, is more prone to ulcerate.

Section II.

Although it was the original intention of the Author to describe the injuries of the organ of hearing in a distinct chapter, yet it appears more suitable not to separate the subject of *foreign bodies in the auditory meatus*, from the account of the chronic diseases of that tube, as such bodies, when present, frequently induce these affections, and they simulate each other in their symptoms.

Foreign subtances are generally introduced by children in their moments of frolic, and, as might be expected, are usually roundish and smooth, for angular bodies would give pain to the little idlers, and they would immediately desist; when these matters are of a soft nature, as beans, peas, &c., they imbibe the moisture secreted by the lining of the canal, and becoming swollen, they are with increased difficulty removed. If the body be round, and so exactly fit the tube as not to move within it, nor to afford pressure; and if the patient be in health, and the ear not irritable, it may remain there many months, giving rise

to little or no inconvenience, and even in many cases hardly interrupting the progress of sound. In instances of a different description, chronic inflammation is excited, occasioning an Otorrhæa, the cause of which may not be suspected; which circumstance alone, if there were no other, imperatively demands that the Surgeon should most accurately examine the meatus, and have the membrane of the tympanum, if possible, clearly exposed to his view in every case of disease connected with that part of the organ. Acute inflammation is also sometimes excited by such a foreign irritant. Frequently the body remains innocuously for many months, and then produces excitement and all its consequences, which may not occur until long after the sufferer has forgotten the circumstance of the introduction of the substance; therefore the vulgar fear "that a stone in the ear will eat its way into the brain," is not altogether unfounded.

The *symptoms* indicating the presence of such a foreign body, are those of the excitement it produces, and ocular or tactile demonstration of the fact; but sometimes such demonstration is with difficulty obtained; in consequence both of the pain occasioned by the necessary dilatation of the meatus, and particularly of the body being surrounded by fungoid growths, the result of the inflammation or ulceration that has been induced; in these untoward cases the examination by the probe will often afford much assistance, and indeed the fungi may frequently be so far separated as to bring the offending body into view.

The medical periodicals teem with unfortunate cases, arising from this cause; it will, however, suffice to mention one or two of many that have been seen by and related to the Author: —

"Mr. G. S., a Surgeon, when eight years old, pushed a pea into his ear; for some few days it was not noticed; the medical attendant was then sent for, who removed only a portion, and that with great difficulty; at the end of a week the remainder was extracted with comparative ease by his mother; for some time no inconvenience was experienced, when a fetid discharge appeared, for which

astringent iujections were employed without benefit. Nothing further than the use of applications for the purpose of cleanliness, was resorted to for nearly twenty years. Almost total deafness existed during the whole period. Two years since, when travelling on the outside of a coach on a very hot day, violent pain was felt in the affected ear; and for two or three days an itching there attracted notice, and a probe being passed down, a black body about the size of a pea fell from the meatus; neither deafness nor other inconvenience has been since experienced."

The Writer has very lately examined the ear, and found the meatus and tympanal membrane quite healthy, and rather of an unusual size. There can be but little doubt that this body was a part of the pea, which had thus remained so long in the tube, and had escaped the investigations of a great number of practitioners, who had examined the canal during that long period.

Harriet Bullock, when between six and seven years of age, put a stone into her ear; it gave rise to no inconvenience until about eight years afterwards, when she suffered more pain than she could express; her agonies, which she referred to the ear, were at times so severe, that in order to prevent self-violence, it became necessary to secure her. Upon passing a pin down the meatus one evening, she heard it scratch against something, and was then reminded of the stone she had introduced so many years previously, and which had been entirely forgotten. The pebble was about the size of a horse-bean, and so firmly attached to the parietes of the canal, and surrounded by 'fleshy growths,' that an accomplished surgeon had great difficulty in removing it; he tried various forceps before he could grasp it; at last he succeeded, and in a short time her recovery was complete.

Mr. Stevenson has reported in the *Edinburgh Journal* the interesting case of Lieutenant Colonel Smith, "who consulted him on the 25th July, for a troublesome discharge from the right ear, accompanied with almost total deafness. In the previous May whilst riding, his horse

sprung out of the road, and forced him with great violence against some branches of a tree, from one of which he received a most severe blow on the right side of his head. The concussion rendered him nearly incapable of maintaining his seat in the saddle. Immediately on recovering himself, he felt a very acute pain in the injured ear. The Staff Surgeons found the integuments of the auricle considerably bruised and lacerated, and the concha and meatus filled with coagulated blood. The latter was removed by syringing with warm water. The local pain and irritation instead of subsiding, as was expected, rapidly increased, and soon induced a high degree of sympathetic fever, with slight delirium. These symptoms were, in a few days, alleviated by the formation and subsequent escape of a considerable quantity of pus from the meatus. After this period, scarcely any uneasiness remained, except on pressing the tragus, which was invariably followed by a very pungent and deep-seated sensation. This, together with the deafness and discharge, was regarded as the mere consequences of the preceding inflammation; for which the ear was washed with warm milk and water, and different injections. When he arrived in London an attentive inspection of the organ enabled Mr. Stevenson to discover something projecting from an accumulation of matter at the farther extremity of the passage, which, by the introduction of a probe, was ascertained to be a solid and slightly moveable substance. The Colonel instantly suggested its being a portion of fractured and detached bone: a suspicion he had constantly hinted to his different medical attendants. It was extracted with some difficulty; and, when cleared from the adhering discharge, it proved to be a rough irregular flat splinter of oak, five lines in length, and three in breadth; one extremity of which, being pointed, had penetrated anteriorly, and in an oblique direction, to the depth of nearly two lines between the cuticular lining and the parietes of the bony canal, close to the membrana tympani. Its presence and position satisfactorily account for the symptoms. Its removal afforded immediate relief from pain, with the *most perfect* restoration of hearing; the ulcer also rapidly healed, and all discharge ceased."

Mr. Stevenson observes on this case, that it is very remarkable that greater and more permanent mischief did not result from the irregularity of the wood, its position, and length of time it remained.

He alludes also to a case, related by Hildanus, "of a girl twelve years of age, who accidentally let a glass ball fall into her left ear. Such was the succeeding inflammation and so violent the pain, that the whole half of the head, and even the extremities of the same side became affected. To these were added other alarming symptoms, which continued for eight years, and only subsided by the removal of the cause."

Bartholine represents his wife to have been for a long time tormented with a pain round her ear, which was at last remedied by small stones being spontaneously discharged from the auditory passage.

The Author removed with his probe without much difficulty a stone from a child's meatus, which had been impacted several months without producing much inconvenience.

The *Treatment* consists in the removal of these extraneous bodies, and it will often be necessary for the Surgeon to risk exciting considerable pain to accomplish this all desirable object. It is evident that the longer it is delayed the more difficult will be the extraction; and unfortunately it often happens, that the body being pushed farther in, by awkward attempts at removal, becomes more firmly impacted, lacerates the lining membrane, and sometimes is forced against, or even through the membrana tympani. Sir A. Cooper has depicted a membrane torn in the attempt to remove a foreign body, of which a copy is given (Plate XII., fig. 6). If the substance be near the outer extremity, and particularly when not occupying the entire calibre of the canal, it may be easily seized with a pair of forceps and removed; the blades of the forceps should be thin, not very narrow, and furnished with well formed teeth, and perhaps they

will be more convenient if their opposed faces are slightly concave. The eye-probe a little curved, may often be carried behind the body to be removed, when the forceps cannot be effectually used; two probes may be passed along opposite surfaces of the substance, being bent somewhat into the shape of midwifery forceps and fastened together, and thus the material will be firmly grasped between them. A small hook, or pair of hooks, may be fixed in a soft substance, though it may be impossible to surround it; the Author has one blade of his ear-forceps furnished with two projecting teeth, between which are received a single tooth of the opposite blade, resembling Assellini's; such an instrument is well adapted to remove fungi. A large body impacted in the meatus should be cut through if practicable, by which its extraction would be much facilitated; this object may often be accomplished even when the substance is hard, by the instrument used by Mr. Costello for dividing calculi fixed in the urethra. The Surgeon's inventive ingenuity will often be in requisition, when the forceps are inapplicable in these cases. If much trouble is expected, it will be better to lubricate the canal with warm oil previous to attempting the extraction.

In some rare cases where the danger attendant upon removing the body in the ordinary manner is great, either in consequence of the large size of the substance, — the depth to which it has been introduced,— the narrowness or obliquity of the auditory canal, or the degree of inflammation already excited, it may be advisable to make an incision between the lower and back part of the meatus and mastoid portion down to the tube, the cartilaginous portion of which may then be laid open, and the body more readily exposed to view and grasped with the forceps.

As illustrative of the great difficulty which occasionally occurs in these cases, and of the unfortunate result which may arise from the Surgeon's mind being pre-occupied by a strong impression, the following abridged report from the *Lancet*, may be transcribed :

"A boy, seven years of age, on Friday whilst at play,

put the round head of a nail into his left ear. He was unable to get it out again, and his father took him to a Surgeon for the purpose of having it extracted. This gentleman told the father that he could distinctly see the head of the nail, and that if the boy would allow him he could easily remove it. The boy objected strongly, and it was necessary to have him held by four men, but their efforts were not sufficient to retain his head at rest, and consequently no attempt at extraction was made. On Monday he was taken to a public institution, and when there he objected so strongly to the examination of his ear, that it was necessary to have him held by several assistants. This being done, the Surgeon introduced a probe, which, when it had been passed about an inch, could be distinctly heard to strike some metallic substance, which appeared to be firmly impacted in the tympanum. As it could not be removed with the probe, several pairs of forceps were successively introduced, and with each of them the piece of nail was taken hold of, but could not be extracted. The Surgeon used as much force as he thought prudent, and from the boy's efforts to get away his head, he must have lacerated the membrane lining the meatus, which was followed by tolerably copious hemorrhage. He was then ordered to be placed in bed, to have his ear syringed with warm water, and afterwards a bread and water poultice to be applied, and in the evening, six leeches to the ear. Thursday. — He has suffered no pain in his ear or head; the several functions are regularly performed, and he appears perfectly well. There is a free discharge of pus from the ear. On the morning of the following Thursday the discharge from the ear stopped, and he complained of headache. Friday. — Much better; the leeches to be repeated. Saturday. — He has very little pain in the head, and appears free from the symptoms which attacked him on Thursday. The Surgeon requested his colleague to endeavour to extract the nail, which he immediately proceeded to do. He began by introducing into the meatus, a director, which he used with so much force, that he bent it; dressing forceps were then employed, with which he laid hold of the nail, and pulled so forcibly, that he bent them also.

Another pair was tried, which unhappily met with a similar fate. A pair of forceps with hooks at the extremities was then used, but they were soon bent straight; several attempts were made with different instruments, but the nail could not be moved, though the operator exerted great strength on the occasion. An incision of about an inch long parallel to the posterior part of the ear was made, and the meatus auditorius was divided. The nail was again searched for, and forceps of different kinds were repeatedly introduced, but they either bent, or slipped their hold every time. An elevator was had recourse to, but it was equally unsuccessful. A pair of tooth forceps was next employed, and after laying hold of the supposed nail, and pulling very forcibly, the Surgeon at length succeeded in extracting three pieces of metal, which appeared to be portions of the head of a nail. Encouraged by this success, he introduced the forceps again, and extracted the *mallet bone;* they were again repeatedly introduced, and though the Surgeon enclosed the head of the nail between the extremities of the forceps, (as he said) nothing but portions of bone were extracted. A pair of wire nippers was now called for, in order to cut the nail in two; but some gentleman observed, that they would be too large to be introduced into the tympanum. He said, that it was evident that the nail was bent, and was 'lying in the posterior part of the tympanum,' and talked of trephining the mastoid cells, but soon abandoned the idea. On looking through the incision which had been made, bone could be seen at the bottom of a deep cavity. The Surgeon said it was the external boundary of the tympanum, and thought that the nail was lying against it; but he again in a few minutes changed his opinion, and said he did not know where it was. The patient had now been on the table about an hour, and it was found that he was nearly exhausted: his pulse could scarcely be felt, and his skin was bedewed with cold perspiration. Some wine was offered him, which he refused; his pupils were dilated, and it was considered necessary to desist from any further attempts; to have him put to bed, and to have a bread and water poultice applied to the ear, and to give ten drops of *Liq. Ant. Tart.*

every four hours. The operator then stated that, 'he had used more force than was warrantable.' He consoled himself, however, that there was now a large opening through which pus might escape if it should form, but yet he feared that part of the petrous portion of the temporal bone would exfoliate, and that inflammation would come on in the brain, and occasion abscess and death. He stated that he had seen three or four similar cases which had terminated in this manner! Sunday. — Has not spoken since the operation; he has been insensible ever since, — groans a good deal, as if in pain, — pupils very much dilated, and the approach of a lighted candle occasions very little alteration in their size. There is no discharge from the ear, — pulse very rapid, and scarcely perceptible, — bowels open once during the night. His mouth cannot be opened sufficiently wide to allow his tongue to be seen. He has not slept since yesterday. A blister was ordered to be applied to the back of the neck, and to take ten grains of *Hyd. c. Creta* every eight hours. Monday. — Is perfectly insensible; has not spoken since Saturday. He continued to groan loudly till ten o'clock last night, but since then he has been perfectly quiet. Countenance is now cadaverous, and lips are exsanguine, — eyelids half closed, — right pupil very much dilated, — left contracted, — a lighted candle brought close to them occasions no change, — pulse cannot be felt in either wrist, — the heart beats very feebly, and rapidly, — respiration hurried and frequent, — there is also gargouillement, — bowels not open since yesterday. Saliva is seen flowing from the corner of the mouth; skin bedewed with cold clammy perspiration. He has taken his medicine regularly, — blister has not risen, — he appears to be in *articulo mortis*. He was visited about one o'clock, but found that he had been dead about an hour.

"*Post-mortem examination four hours after death. Head.* — About four ounces of serum were found, between the dura mater and arachnoid membrane. There was softening of the entire extent of the base, and of the anterior part of the hemispheres. The vessels on the surface were very much distended, but the substance of the

brain was pale. The ventricles were examined, but nothing particular was discovered in them.

"*Ear.*—The temporal bone being removed from the skull, and the soft parts stripped off, the cavity of the tympanum was immediately brought into view, without anything else being done. Not a vestige of the bony portion of the meatus auditorius externus remained, the whole having been removed in the operation, and the floor of the tympanum was also wanting. The remaining portion of the tympanum was covered with pus, which being washed off, the surface of the bone beneath seemed highly inflamed. The nail not being in the tympanum, sections were made through the cochlea, vestibule, semicircular canals, and mastoid cells; but there was no nail to be found!"

The injurious consequences which may arise from the extraction or the previous presence of these bodies, are to be remedied accordingly.

It is quite distressing to read the details of dreadful suffering produced by the presence of insects and worms in the meatus, and sometimes also in the tympanum. Doubts still exist as to the manner in which these beings obtain a residence in the human Ear: certainly, they are generally formed by insects being attracted into the auditory canal, by the discharge which may be going on, and there depositing their ova, which in time are converted into worms; the eggs may be dropped upon the orifice of the tube, and be afterwards conveyed inwards by the *ciliæ*, if such exist in the Ear; it is also possible that they may be generated there in the manner in which the entozoa are supposed to be formed in the intestine, and other parasitic animals in the different structures of the body. It has likewise been imagined that worms may crawl into the meatus of a person lying upon the ground asleep. However they may obtain possession, numerous cases are recorded of their existence, and of the dreadful sufferings produced by them. The symptoms to which they give rise are those of irritation, generally of intense character, and often passing on to suppuration; and as these animals usually are found in cases

of otorrhæa, the disease is exasperated by their presence, and if the tympanum were not previously affected, it generally soon becomes implicated. They collect in large quantities in the tympanal cavity, and it appears also in the mastoid cells; and increasing in their size and number, they in proportion augment the sufferings of the patient. Itard relates several cases, most of them quoted from other writers:—

"A boy, six years old, was afflicted with slight suppuration of the meatus of the left Ear, unattended with pain; but little was done for it. In about a month he complained of acute pain, which was relieved by bland tepid injections; this continued to return, and was relieved; at length the intervals of ease were shorter; in a few hours it became so acute, as to produce convulsions, and some drops of blood escaped from the Ear; bleeding and anodynes were resorted to without effect. The agony and convulsions continued, with hemorrhage from the Ear, for two days, notwithstanding the bleedings and narcotics, general and local. About seven in the evening the convulsions became less violent, the pain diminished, and the patient complained of something gnawing his Ear. His mother, who was alone with him, perceived a white body in the auditory canal, and having introduced a needle, succeeded in extracting a pretty large white worm, which she threw hastily on the ground, where it writhed and crept about. Terrified at this occurrence, she immediately sent for the medical attendants, who instantly recognised the cause of the child's sufferings, and, as these had not entirely disappeared, suspected that some of these animals might still remain. By means of small forceps, the Surgeon extracted two worms, similar to the first. The hemorrhage then ceased, the pain subsided, and the convulsive motions disappeared; the child quickly fell asleep, and when he awoke, seemed quite well, with the exception of a slight suppuration in the auditory canal, which in a few days subsided. The worms were inclosed in a phial, in which they were, in the course of thirteen days, converted from the chrysalid or pupaceous to the flying condition, when they were recognised to be the same species of flies which frequent

places occupied by putrefied animal and vegetable matter."

Acrel mentions the case of a "woman, who had been deaf a long time, and was suddenly seized with acute pain in the ear, and violent convulsions, without apparent cause. They several times returned, and became more vehement. A piece of lint, moistened with oil and laudanum, was introduced into the meatus, and on removing it the next day, several small round worms were observed upon it, and from that period all symptoms disappeared. Valsalva reports a case, somewhat similar, but of longer continuance, in which the membrane of the tympanum was destroyed, and worms, like small silk-worms, were discharged at long intervals."

If these creatures can be seen in the meatus, they must be immediately removed with the forceps; if they be too small or numerous to be seized by the instrument, a pledget of lint covered with oil and honey may be introduced, to which they will sometimes adhere; a few drops of the infusion of tobacco in the oil of almonds may be passed down the canal, or the smoke of tobacco may be used, which does not appear to injure the tube, but is fatal to its noxious inmates; if the tympanum be exposed, and the worms are contained in it, the smoke of tobacco may be thrown through the Eustachian tube, and be thus brought into more immediate contact with them.

Section III.

CHRONIC INFLAMMATION OF THE MEMBRANA TYMPANI

Will not require so extensive a discussion as its importance deserves, in consequence of most of the diseases described as appertaining to the auditory canal, affecting likewise this important membrane; and because the observations then made are likewise applicable to the affections of this structure.

The membrane, however, is sometimes chronically

inflamed, independently of disease of other structures; and this may be produced by any of the causes of increased action. Although this affection is often the consequence of acute inflammation, yet it more frequently commences in the chronic state.

The Surgeon can only ascertain the precise condition of the organ by accurate inspection; the symptoms cannot be distinguished from those of disease of the meatus, or of the tympanal cavity. Dulness of hearing is induced, varying in degree according as the extent of altered structure interferes more or less with the vibratibility of the membrane; and very often from this cause alone the cophosis is nearly complete. There is also uneasiness referred to the bottom of the meatus, sometimes a pricking sensation, and even pain, extending into the deeper structures of the organ, and to the head. In most cases a discharge occurs from the canal, varying in quantity and quality, and in both conditions frequently changing, which is secreted by the surface of the diseased membrane; but this is by no means always the case. The Author has very recently examined the Ear of a woman who has long been very deaf; formerly a fluid escaped from the canal, but it is now and has been for some years unusually dry and capacious; the membrana tympani presents a white opaque appearance, seems to be less than usually concave, and the attachment of the manubrium of the malleus is not distinguishable.

The organic alterations in this structure produced by chronic disease are very numerous. The usual appearances of this degree of inflammation may exist, as redness, varying from a slight tinge to a dark brown, occupying the whole surface, or confined to different spots. The membrane may be simply thickened and opaque, somewhat resembling the appearance of the nebulous cornea. Little incrustations may cover its surface, and which will occasionally fall off; these are sometimes adhesive deposits, and in other instances inspissations from the muco-purulent secretion. Little hardened vegetations, more or less vascular, may partially occupy the surface of the membrane; and from it also polypi or fungi occasionally proceed; these growths, as in the meatus, vary in different cases from extreme softness, resembling a

congeries of bloodvessels to a scirrhous hardness. They give rise to a similar train of symptoms, as when seated in the meatus, excepting that the deafness is usually more complete, and the danger of extension to the tympanum is greater. The most constant effect of chronic inflammation of the tympanic membrane is ulceration, which, as in other structures, may vary in extent from a minute perforation, to a complete destruction of the whole membrane: the ulcer generally commences immediately in front of the inferior point of the malleus, or below it, rarely behind it; sometimes a central flap of the membrane alone is remaining, to which the malleus may continue to be attached; more frequently the whole is removed, except a narrow border round the entire circumference; and in numerous instances no trace whatever of this structure is left. When the membrane is so extensively lost, the ossicula auditus are also implicated in the destruction; the malleus must be removed; and generally also the incus, with the orbicular, leaving the stapes attached to the fenestra ovalis and its membrane. It sometimes, but not commonly, happens, that the incus still continues united by its short process to the parietes of the tympanum, notwithstanding the loss of the malleus, of which a case has been already described; and when this occurs the bone can be readily seen (Plate XII., fig. 12).

An inexperienced observer may hardly be able to detect the ordinary appearance presented by the entire loss of the membrane; as all will appear dark to his view; and it is sometimes difficult for the more experienced examiner into the state of the ear to ascertain the presence or absence of the stapes, in consequence of the, perhaps, unusual length and narrowness of the auditory tube, but more especially because of the obliquity of the cavity, and of the little bone presenting only its small head, being deeply seated, and thrown into shade by the projecting promontory. A little glistening spot may, however, generally be recognized above the anterior part of the promontory, which is the head of the ossiculum, whereas, were it absent, a dark spot would occupy that point.

In order that the Surgeon may be enabled to look com-

pletely through the meatus to the membrane, and perhaps into the cavity of the tympanum, it is necessary to remove the natural obliquity of the auditory canal, as well as to dilate the tube, and to throw a strong light to its very bottom. It is evident that these indications are much more easily accomplished in some persons than in others. The Author frequently examines an ear, in which, by simply drawing the auricle upwards and backwards, the membrana tympani is exposed in consequence of the great capacity, slight obliquity, and short course of the canal; whereas, in others, it is with considerable difficulty a good view can be obtained, the conditions being the reverse. In many cases the tube may be sufficiently dilated for the purpose of investigation, by drawing with one hand the auricle upwards and backwards, and with a probe in the other pressing the anterior wall of the meatus forwards. This proceeding ought not to supersede the use of the *speculum*, which in all instances more completely dilates the tube and removes the obliquity; in addition to which the unpleasantness to the patient is not so great from the more general pressure of this instrument as from the use of the probe; the polished surface of the speculum will also increase by reflection the quantity of light; and the Surgeon's hands, being out of the way when holding only the handles, will not interfere with his view; it is therefore better in all cases to employ this instrument, and this will be particularly evident upon witnessing to how great an extent the canal may be gradually dilated by this method, without producing inconvenience. The rays of light are to be direct, and made to pass quite to the bottom of the tube, the quantity may be advantageously increased by a reflecting medium conveniently placed for that purpose; hence it will follow that the sun's direct rays should be taken advantage of, whenever practicable; and if the light of day be but obscure, artificial illumination must be had recourse to, and the more the light is concentrated upon the meatus the better; a wax taper generally answers the purpose very well; an Argand lamp still better, but unfortunately it is less useful than otherwise it would be, from its want of portability. Kramer has depicted, in his work, an Argand

lamp placed in a box, furnished with reflectors, and a tube converging the light to one small space, and in the brilliant collection of rays thus formed the ear is to be placed; such a convenient contrivance is very simple, and often used for other purposes.

Different specula have been used at different times, that generally in vogue in this country is very similar to the one used by Itard, Deteau, and other Surgeons on the Continent; a little variation has been lately made, in giving it a greater curve backwards from the blades, that it may be less in the way of the tragus, which may be an improvement, but it is a trifling one. Kramer's speculum has the blades so constructed, that when closed they form a circular, and not an oval tube, with their points much contracted.

The Author finds, upon experience, that Kramer's modification is much less convenient than that in general use, as the sharp edges of the narrow extremity produce pain, by injuring the lining of the osseous portion of the canal; and when the instrument is not introduced far enough to produce that effect, it is altogether useless (Plate XVI., figs. 1, 2).

It is known to every practitioner of aural surgery, that the patient rarely complains of the stretching of the outer division of the canal, but directly attempts are made to enlarge the osseous part, pain is occasioned; yet it is also requisite to make a certain degree of distension upon the lining of that part of the tube.

When an aperture, larger or smaller, exists in the membrana tympani, air may be forced through it from within; this is effected by the patient closing the mouth and nostrils, when, upon making a forcible expiration, as in blowing the nose, the air must pass through the Eustachian tube into the cavity of the tympanum, and find its way out through the imperfect membrane. The rushing of the air is sometimes so distinct as to disturb the hair hanging over the meatus, to flicker the flame of a candle, and to be distinctly felt or heard as a whistling sound by the attendant; when mucus or other matter is in either of the canals of the tympanum, a gurgling noise will be produced, and air-bubbles, if in the meatus, will be seen mixed with the fluid. By this little experiment, a perfo-

ration of the membrane may often be detected, when a fungus or other tumour conceals it. When warm water is injected through the catheter introduced into the Eustachian tube, it will generally escape by the aperture of the membrane into the meatus. The Author has in this manner detected the existence of an imperfect membrane in a child, in whom, being deaf and dumb in consequence of fever during its infancy, it was impossible to make any other investigation. The presence of these signs clearly indicates the imperfect state of this structure, but their absence is no proof of the contrary; some persons, as children, cannot be taught to make the necessary effort of expiration, and frequently the Eustachian tube being closed partially or completely, or the cavity of the tympanum being occupied by pus, mucus, or blood, the transmission of air will be prevented.

Sounding the membrane by carefully striking it with the probe, will assist in indicating its condition; if perfect, it will present an elastic feel, produce pain, and excite a noise, and unpleasant sensation distinct from pain; when it is diseased, or ulcerated, the pain will be generally less, the elasticity imperceptible, and the noise not excited; when the probe passes through an aperture of the membrane, it is distinctly recognized to strike against the inner osseous wall of the cavity.(*a*)

In the *Treatment* of Chronic Inflammation of the Membrana Tympani, and its effects, the Surgeon must never forget that there is much greater probability of stimula-

(*a*) "The diagnosis of chronic inflammation of the membrana tympani may always be established, by syringing out the meatus perfectly clean; investigating it by the aid of the speculum in bright sunshine; and testing with the probe the sensibility or insensibility of the thickened membrana tympani, and of the polypous excrescences which cover it. Should the perforation of the membrane not be evident, and therefore doubtful, the patient should first endeavour to inflate the cavity of the tympanum, by making an effort to blow the nose, with the mouth and nostrils closed. If the air does not then pass through and out of the meatus with a whizzing noise, a stream of air should be directed into the cavity of the tympanum, from the air-press, by means of a catheter, in the manner hereafter to be described, which will certainly pass up to the membrana tympani, and through the meatus." —*Kramer.*

ting applications exciting inflammation of the tympanum than when they are applied solely to the meatus. With this caution the treatment will be the same as for similar diseases affecting the auditory tube. The judicious practitioner will therefore very gradually increase the strength of the astringents and escharotics which he may deem it advisable to employ; and will rather apply them upon a camel's hair pencil-brush, than by means of injection. Dr. Kramer strongly recommends, as the most efficacious application to the chronically thickened and inflamed membrane, a solution of the acetate of lead, varying in its strength from one grain to ten in an ounce of water; when used in the last proportion he says, the membrane is covered by the fine powder of the salt, and its action kept up so much the longer.

The removal of a polypus or fungus from the surface of the membrane must be accomplished, either through the agency of astringents, or mild escharotics, or be at once cut off with a small curved knife, as twisting or lacerating such a growth would almost certainly be attended with a forcible rupture of the membrane, the evil consequences of which could not be calculated.

Dr. Bennett, in his able translation of Kramer's work on the Diseases of the Ear, has alluded to the possibility of an ulcer of the membrane healing under the influence of mercury, and has cited a case of Mr. Smith's, in which such a result did partially occur, the very imperfect cicatrix was, however, rapidly reabsorbed; therefore in the present state of our information such an ulcer must be considered incurable.

Chronic inflammation is not the only cause of perforation of the membrana tympani. We have seen that it very constantly arises from an abscess of the tympanum, from which disease it probably most frequently occurs. It may also be ruptured by direct violence; and among other authors, Sir A. Cooper has related a case of laceration in the attempt to remove a pin, of which injured membrane a representation is given, and a copy accompanies this treatise (Plate XII., fig. 6). A blow upon the side of the head may also cause a rupture; by compressing, according to Sir A. Cooper's idea, the air of the meatus forcibly against the membrane; this effect may probably also occur by the extension of concussion through the

cranial bones. Injuries, by producing extravasation of blood into the tympanal cavity, may occasion appearances of the membrane in some degree resembling those of its chronic inflammation, and it is possible that when the effusion is sudden and extensive, the membrane may be torn by the pressure.

An aperture is also made in the membrane surgically, for the admission of air into the tympanum, when stricture or other affection of the Eustachian tube prevents its usual mode of entrance. To which operation allusion will presently be made.(*a*)

(*a*) Simple opacities of the membrana tympani are declared by Kramer to be quite beyond the reach of art. If this membrane be considerably thickened, quite insensible on being touched with a probe, and of a cartilaginous hardness; and if, in consequence of this, the hearing has seriously suffered, there remains, according to this writer, no other resource but perforation of the membrane. But before this operation is attempted, the diagnosis should, as he very properly enjoins, be made out in the clearest manner.

PLATE XIV.

Fig. 1. — Master B.'s right ear; — a small portion of the Membrane of the Tympanum remaining, well showing the Promontory, with the oval and round apertures in outline; — ossicula lost, hearing good.

Fig. 2. — Master B.'s left ear; — rather more than the anterior half of the Membrane of the Tympanum is removed by ulceration, the Malleus being plainly seen attached to the edge of the remaining portion; the posterior wall of the cavity seen through the ulcer.

Fig. 3. — The right ear of Mary Ann Lee, showing the opacity of the Membrane of the Tympanum, and a small vegetation at its lower margin.

Fig. 4. — The left ear of John Austin; — the Meatus occupied by an immense fungus, which is represented projecting behind the Pinna, through a large aperture in the Meatus, produced by exfoliation of its osseous portion.

Fig. 5. — The right ear of Master C.; — the Membrane of the Tympanum entirely lost; the Malleus attached by its head and long process to the osseous wall, the handle being exostosed; the Incus seen in outline; the mucous lining thickened.

Fig. 6. — The left ear of Master C.; — a small upper part of the Membrane remains, giving attachment to the head of the Malleus, which is seen to hang below its margin.

Plate 14.

Fig 1.

Fig. 2.

Fig. 3

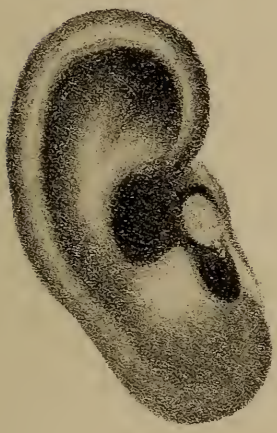


Fig 4.

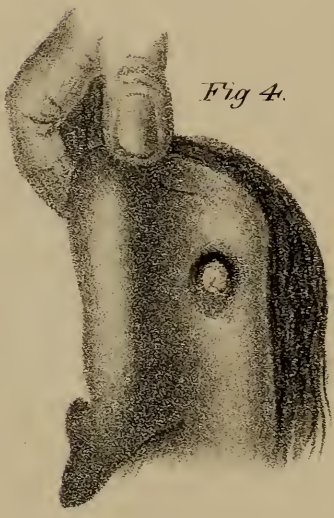
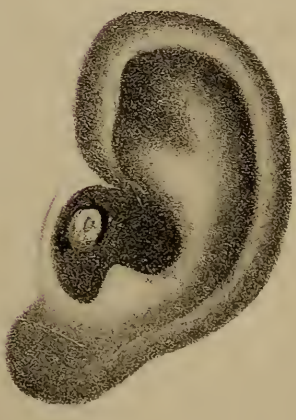


Fig. 5.

Fig. 6.



Section IV.

CHRONIC INFLAMMATION OF THE TYMPANUM.

(*Otitis Interna Chronica.*)

A treatise might be composed upon this affection of the ear alone, as it is of very frequent occurrence, is generally combined with External Otitis, is a common cause of more or less deafness, and in its effects is sometimes fatal by exciting disease in the brain. In the former part of this Essay, we have, however, treated so fully of Acute Otitis, and have incidentally touched upon several points connected with the chronic form, that a more brief description than the importance of the subject would otherwise require, may suffice on this occasion.

The seat of the inflammation is the mucous membrane of the cavity, but it frequently extends to the cellular tissue, and onwards to the periosteum and the bone, affecting likewise one or all of these structures in the mastoid process, as well as in the Eustachian tube.

In addition to the causes to which allusion has been already made in treating of the similar affection of the meatus and tympanic membrane, the disease under consideration is very often excited by the extension of morbid action originating in the outer portion of the ear; though more frequently perhaps, it commences in the cavity of the tympanum or Eustachian tube, and spreads outwards through the membrane to the meatus, rather as a consequence of Acute Otitis than as a chronic affection from the commencement.

The *symptoms* of Chronic Internal Otitis, when it is an extension from an external disease, do not materially differ from those of the latter affection; but as the inflammation and its consequences extend to the cavity they increase in severity; the slight pain becomes more urgent, dragging, pricking, and occasionally shooting into the head, — the discharge is more copious, and more frequently bloody, — and when the Eustachian tube re-

mains pervious, it often escapes into the pharynx and mouth, — the deafness is also much augmented, and if the matter discharged be from the beginning carefully examined, the malleus or incus, or both, will generally, at some time or other, be observed to escape. When the disease begins in the cavity the dull heavy uneasiness is more severe, accompanied with lancinating pains through the head, — the deafness is more considerable, and often complete on that side, — and there is frequently drowsiness and torpor, with slight delirium, and sometimes a chilliness, with a little febrile reaction. This condition may continue for weeks or months, the patient being sometimes better, then again worse. In the ordinary course of the disease, the membrana tympani ulcerates, and a discharge suddenly takes place, affording considerable relief to the patient, — the matter continues to escape, varying as noticed above, and with it, sooner or later, the ossicula, and thus an Otorrhæa is established, which may exist for a very indefinite period. Usually after some months, the discharge ceases ever to be sanguineous, it becomes mucous, then almost serous, and gradually subsides; during which subsidence the ceruminous follicles by degrees assume their healthy secretion. Hearing is partially restored, to an extent chiefly regulated by the degree of disorganization which has occurred in the cavity and its contents.

This is the bright view of a dangerous malady, and the one which the Author is happy in thinking most frequently presents itself. The tympanum on examination, affords a variety of appearances; generally the membrane lining it is darker and firmer than usual, which is particularly the case whilst it is secreting pus; as the disease subsides the mucous membrane assumes a more healthy appearance. If the membrana tympani be extensively removed, the remaining little bone or bones may be distinguished; and water injected gently into the ear will pass through the Eustachian tube, producing but little inconvenience; but this effect is more readily produced in the opposite direction, by injecting water through the Eustachian tube and tympanum into the meatus. At other times diseased growths will be detected proceeding

from the mucous surface, which are generally mild fungi, and as long as they continue, will maintain the diseased secretion. It is a common circumstance for the mucous membrane to become thickened and spongy, obscuring the usual appearances of the exposed cavity, and which projecting a little outwards, may be mistaken for a fungus of the meatus, or tympanal membrane. When the mucous lining is thickened and granulated, and affords a secretion only sufficient for lubrication, the tympanum being filled up, will be defended from the injurious effects of variation in the atmosphere and other irritants.

Unhappily a dark prospect often presents itself during the progress of this affection; the inflammation involves the cellular tissue, obliterates by adhesive deposit the Eustachian tube, reaches the periosteum, and eventually the bony parietes, extending also backwards to the mastoid cells; which latter process sometimes exfoliates, forming an external wound through which portions of bone escape, with large quantities of extremely fetid matter, and in this manner the tympanum may be relieved, the natural communication between it and the mastoid cells having been considerably enlarged, and the cells being often converted into a single cavity by the ulceration of their parietes. After distressing the patient for many months, even this condition of parts may be to a great degree recovered from, and hearing to a certain extent enjoyed. Such recovery, however, can only be hoped for when the patient's general powers are great, and when no exciting cause has been applied during the progress of the disease.

On the other hand, if the disease has existed for some time, before the membrana tympani has ulcerated, the symptoms of chronic cerebral affection are more urgent, — the patient becomes lethargic, and is often with difficulty roused; his deafness is much increased with the dull weight in his ear, which now extends to the brain, producing at times slight delirium, and sometimes accompanied by convulsive motions. Vomiting frequently happens after eating, and food is taken sometimes voraciously, at other times with loathing; the bowels are generally costive, with an occasional diarrhœa, — the

secretions are diminished, and the patient becomes gradually comatose and expires. During this course of the disease, the membrana tympani generally gives way, and the escape of matter affords some relief to the urgency of the symptoms, which is, however, only temporary, as they return and the affection progresses to a fatal issue. In such a case, and many are recorded, the chronic inflammation, which in the majority of cases has been maintained, if not increased to the acute degree, by the matter contained in the cavities of the organ becoming decomposed, has given rise to ulceration of the petrous portion of the temporal bone, and generally either at the upper surface or roof, or at the posterior wall of the tympanal cavity, thus reaching the dura mater, which then becomes inflamed, and pus is effused between it and the bone, or it may be between the cerebral membranes. Sometimes the brain itself becomes extensively diseased, and suppuration takes place in its structure with thickening of the membranes. The extent of the caries of the bones of the head varies considerably, at one time confined to a part of the petrous portion, at another occupying the whole, and extending to its squamous plate, and even to the sphenoid and occipital bones.

This unfortunate spreading of the disease to the brain, still more frequently arises during an otorrhæa from the tympanal cavity, which may have existed for a very long period without producing more than ordinary inconvenience; when, upon the application of an exciting cause, either general or local, an increased action takes place, and the disease extends more or less rapidly to the membranes of the brain, or to the brain itself, thus presenting all the characters of acute internal otitis.

The two following abridged reports of Dr. Abercrombie's cases are too interesting to be overlooked, and though probably they are known to most members of our profession, but little apology is required for their insertion, as they are admirable illustrations of the subject under discussion.

"A gentleman, aged twenty, on January 20th, 1820, complained of violent toothache, on the right side of the

jaw, the pain extended to his ear and afterwards to his temple, which partly confined him to his bed. Leeches were applied, and aperients were administered, which latter he vomited. The pain now affected the head, causing him to become delirious, his pulse being seventy, and of moderate strength, — the headache still continued, especially about the forehead, — his face was pale, — he was still delirious, and his pulse sixty. He was now treated antiphlogistically, which he bore well. He seemed much benefitted by the treatment, and on examination of the ear a fetid discharge of matter was observed, his pulse varying from ninety-six to one hundred and twenty. On seeing the patient on the 29th, the right eye was observed to be suffused, the ball of it turgid and enlarged, and the cornea covered with a yellowish slough, — the mouth was perceived to be drawn to the left side, — from this time he began to sink, and on the morning of the 30th he died.

"*Inspection.* — There was some effusion under the arachnoid on both hemispheres, — much effusion in the ventricles, and extensive *ramollissement* of the septum lucidum, the fornix, and the cerebral matter bordering upon both lateral ventricles. There was extensive caries of the right temporal bone, — behind the ear on the thin part of the bone it was very dark coloured, very soft, and when cut into, discharged matter from its cancelli, and from the cavity of the ear; the dura mater corresponding to the temporal bone was much thickened. The part of it which lay anterior to the petrous portion was in a state of recent inflammation, — the part behind the petrous portion was much thickened and spongy, — and between it and the bone there was a deposition of thick purulent matter. From this place the disease had spread along the tentorium, over nearly the whole surface of the cerebellum, on almost every part of which there was a deposition of coagulable lymph, with thick flocculi of purulent matter; this was most abundant on the tentorium, and on the right and posterior parts of the cerebellum, and it was traced into the fourth ventricle. Under the cerebellum there was a considerable quantity of pus,

and in its substance there was a small abscess in the posterior part betwixt the two lobes."

Although Dr. Abercrombie does not allude to a disease of the ear in this case, previous to the illness of which he has given the history, there can be but little doubt that such had existed; this instance furnishes an example of a frequent occurrence, namely, neuralgia of a tooth, or several teeth on that side, consequent upon disease of the tympanum.

"A girl, aged nine, had been liable to attacks of suppuration of the ear, which were usually preceded by severe pain, and some fever. On suffering from one of these attacks she was not relieved by a discharge of matter as formerly, but continued to be affected by pain over the forehead, impatience of light and some vomiting; her look was oppressed, the pulse eighty-four. Antiphlogistic means with mercury were applied, without producing relief. She died suddenly about three weeks after the attack, having evidenced all the symptoms of inflammation of the brain with convulsions, but continuing sensible and without squinting, blindness, or coma. The left ear had continued to discharge matter, and an opening had formed behind the external auricle, from which also there was a purulent discharge.

"*Inspection.* — A considerable quantity of colourless fluid was found in the ventricles of the brain. The brain in other respects was healthy. In the left lobe of the cerebellum there was an abscess of considerable extent, containing purulent matter of intolerable fetor. The dura mater, where it covered this part of the cerebellum, was thickened and spongy, and the bone corresponding, to this portion was soft and slightly carious on its inner surface; but there was no communication with the cavity of the ear. The opening behind the ear merely passed behind the external ear, and communicated with the external meatus."

Dr. Abercrombie describes a third case, in which inspection after death showed that inflammation had ex-

tended from the tympanum to the dura mater, without producing caries of the bone. He also alludes to several other cases, the perusal of which will repay the reader.

The Author was requested to see Mr. Gallichan, a Medical student, who had been subject to a pain in his head, for a considerable time. About a year previously he had an attack of toothache, and general pain in the face, followed by a discharge from his left Ear, which afforded him relief; it continued a few days, and then subsided. In about a year afterwards, in consequence of taking cold, he was attacked with pain in his head, which in a few days was again somewhat relieved by a discharge from the affected ear; the matter was offensive, and he was in the habit of removing it with twisted paper. He continued occasionally better and worse, but still able to attend to his avocations, though his friends noticed that he was declining in strength. In about five months after, the affection being renewed by taking cold, he was violently attacked with pain in the head, which occupied the whole of the affected side, and suddenly returning at intervals with such severity as to make him jump from his bed almost in a state of frenzy, rolling on the floor and threatening to throw himself out of window; though confined to his room, he objected to lie in bed, asserting that the pain was there increased. For a fortnight previously to his death, he was constantly tossing about in a state of low delirium; during these sufferings the ear only occasionally discharged, and the symptoms of pressure on the brain became daily more evident. Antiphlogistic remedies were utterly useless, and he died comatose. Unfortunately an inspection of the body was not allowed, but the symptoms were so unequivocal as to leave no doubt of the extension of disease from the tympanum to the membranes of the brain, and consequent suppuration.

"A young man, aged 17, complained of pain and immobility of the neck, frequent headache, and a fetid discharge from the left Ear, which had continued several weeks. This discharge had been preceded by acute pain, it came on suddenly, and had been very copious from its

first appearance, with an offensive smell. He had been deaf in that Ear for some months, but did not seek medical assistance until matter flowed from it. The neck was then blistered, the Ear syringed, and medicines administered, by which the pain of the Ear was relieved; but the neck became more stiff and painful, so that at length he was unable to turn his head in the least. I found the muscles on the left side rigid, and every part of the neck exquisitely sensitive, but especially near the Atlas, and the least jarring motion caused agony. Notwithstanding he represented his sufferings to be continual, and his nights very frequently dreadful, his appetite was good, and his strength sufficient to enable him to pursue his employment as a compositor in a printing-office. His countenance, however, was extremely pallid and anxious: pulse 90, and feeble. From these symptoms I inferred that he laboured under otitis, which had probably been communicated to the bony structure of the internal Ear, and other parts in the base of the skull; the prognosis was therefore unfavourable. Leeches, fomentations, mercurials, and gentle aperients produced intervals of relief. The malady, however, evidently continued to advance, and at length he could no longer support his head, without the aid of his hands, nor separate his teeth more than half an inch. He lived in continual terror of moving, and felt, he said, as if his neck were broken. Considerable distortion of the cervical vertebræ was now apparent; the spinous process of the dentata projected much towards the right side, more than an inch from the mesial line, and a slight crepitus could be felt upon passing the finger from the first to the second vertebra. On either side of the Atlas there was an unusual fulness, but the central part appeared depressed, and it yielded to gentle pressure, which often seemed to produce a flow of pus from the diseased Ear. A burning pain came on in violent paroxysms, extending, as he described it, all over the inside of his head; it was excited by the least motion, and while it lasted, he raved like one labouring under phrenitis; its duration varied from half an hour to two or three hours. He became hectic and extremely emaciated; obtained no sleep without narcotics, which often

procured a night's complete rest. A succession of blisters were applied, but without benefit. In this miserable manner he proceeded, with little variation, for six weeks, when, while his nurse was attempting to assist him in raising his head to move his pillow, he suddenly became paralyzed in every limb. His intellect remained perfectly clear, and his pulse continued about 90; his respiration was not remarkably affected, but he passed a motion without his knowledge. He died calmly, about six hours after the occurrence of this perfect paralysis.

Inspection of the body.— On handling the neck, pus flowed abundantly from the Ear. Upon removing the calvarium, we found the dura mater rather adherent, and more fluid than usual in the arachnoid cavity. The brain appeared healthy, except that it was somewhat injected. No other signs of disease existed within the skull, but pus poured from the spinal canal through the foramen magnum. When the muscles of the neck were dissected, those of the left side were found degenerated and pervaded by veins of curdled pus. The Atlas was tilted on one side, and very moveable. On detaching it from the occiput, we discovered that portion of the mastoid process, including the digastric fossa, and that part of the occipital bone connected with the left condyle partially destroyed by caries. The left occipito-atlantoid ligaments were reduced to a pulp, and the glenoid surface was denuded of its cartilage and roughened. The processus dentatus was carious, and its ligaments were obliterated. The theca connected with the first and second vertebræ was inflamed, and surrounded by pus, and the medulla itself broken down and mixed with sanious matter. The ulcerative action had commenced in the articulating surfaces of the Atlas and Dentata; and an opening existed between the oblique processes of the second and third vertebræ on the right side, which communicated with an abscess among the muscles, and opened by a small aperture into the upper and back part of the pharynx.

Among the patient's complaints I should mention, that

not the least troublesome was frequent priapism, with involuntary emissions, without sexual desire."

This case has been given at length, and in the words of the intelligent Surgeon who attended it, as the Author believes that it is one of the most interesting on record; showing the extensive devastation which the burrowing of a tympanic abscess may produce; the disease appears to have extended from the tympanum to the mastoid process, which, becoming ulcerated, the abscess passed through the muscles to the spine, &c., producing the disorganizing effects above described, and not, as in the more ordinary mode, extension to the brain. The unhappy sufferer's life was a little shortened by the accidental partial dislocation of the Atlas.

"Mrs. Hawes, a poor woman, was the subject of tic-doloureux, which was attended with deafness on that same side, and occasional attacks of pain in the head accompanied by delirium. As her health did not materially suffer, she was deemed by some to be an impostor. During an attack of unusual severity of the neuralgia of the ear and face, accompanied by cerebral disturbance, a discharge suddenly occurred from her ear, which afforded some relief; it was, however, temporary, and the cerebral affection increasing, she died comatose." In this instance again the Surgeon was prohibited from making a *post-mortem* examination. The case is notwithstanding interesting, as showing that sometimes the chronically diseased tympanum will excite neuralgia in the chorda tympani, or the tympanic plexus, which, extending to the facial nerves, will simulate the symptoms of the painful face.

The Writer has lately examined the right ear of Harriet Mahoney, aged twelve years, which is affected with Otorrhæa, the membrana tympani is removed by ulceration, and granulations occupy the tympanic cavity, — the discharge is still fetid. The Author is informed that during the progress of the acute stage of the disease, the

child suffered from paralysis of the opposite side of the body, indicating pressure on the brain, which was afterwards removed. Probably the cerebral membranes, or the brain itself, were inflamed consecutively upon the Otitis, which terminated in serous effusion, which fluid afterwards became absorbed.(*a*)

(*a*) The following case possesses interest in connexion with the present branch of inquiry. It is related by Mr. Roderick (*London Lancet*, 1839–1840, p. 239).

"Miss ———, aged nine, a private patient of Mr. Callaway, had never been of a strong habit of body, but had in general enjoyed a good state of health, until the beginning of the year 1835, when she became affected with scarlet fever, but soon recovered. Soon after convalescence, however, she became subject to deafness, with pain in the left ear, accompanied by a discharge of a thin purulent secretion of a fœtid odour. An 'aurist' was consulted, who ordered an injection, probably of the sulphate of zinc, into the ear, with little benefit.

"On Monday, the 19th of March, 1838, the pain in the ear became suddenly much more acute, and occupied a much larger portion of the side of the head than on former occasions. So extensive was the seat of this pain, that pressure applied to the mastoid process, caused a considerable aggravation of her sufferings. Pulse 80, and compressible. On the 20th the pain in the head was more severe, and occupied the greater part of the left side of the cranium. She also complained that the eyes were somewhat irritable, and that she could not bear the light of a candle. On the 22d the pupil of the right eye was observed to be somewhat larger than that of the left, though it was still obedient to the impression of light. There were, occasionally, convulsive movements of both the upper and lower extremities of the right side. During the intermission, however, of the latter, she possessed full power over both extremities. About nine o'clock on the evening of the 22d, she called for coffee, which being swallowed, was immediately vomited. The pulse was now 70 and rather laborious. She was perfectly sensible, and answered questions put to her. She continued sensible until nearly one o'clock, when she died. The head only was examined after death. All the bones of the calvarium were remarkably healthy, with the exception of the petrous portion of the left temporal, the anterior surface of which was of a reddish appearance, caused by increased vascularity, while a portion of the surface opposite the cerebellum was roughened from ulceration. On sawing through the petrous portion to expose the internal ear,

Mr. Liston possesses in his museum the three following preparations of morbid products connected with the tympanum, two being of great interest: —

"Pars Petrosa of the temporal bone cut, exposing an abscess of the internal ear, with soft deposit to a slight extent. The patient, a female, aged eighteen, had for a long period profuse purulent discharge from the ear. The evacuation became suppressed, and violent headache, coma, and death ensued."

"Pars Petrosa extensively broken up, and almost entirely covered by a soft medullary fungous tumour, which proceeds from (and has in all probability originated in) the cavities of the ear. The patient, a male, aged forty-seven, had been subject to severe headache, almost con-

a quantity of pus was found in the latter, and the lining membrane was, in several plaees, destroyed by small ulcers. Both the cavity of the tympanum and the labyrinth had suffered from the disease; there was also a cavity containing about a dram of fœtid pus, within the mastoid process of the temporal bone. The dura mater was healthy, with the exception of a small portion which lay in contact with the diseased part of the petrous portion of the temporal bone; and here it was externally coated with pus, somewhat thickened, and of a darker colour than natural.

"The arachnoid was somewhat opaque in most places, but in the neighbourhood of the diseased bone the opposite portions were feebly adherent and coated with recently effused lymph. There was a large quantity of fluid infiltrated in the pia mater, and the vessels of this membrane were somewhat congested. The convolutions of the cerebrum were well developed. The cortical and cineritious portions were a little more vascular than in health; each lateral ventricle of the brain contained about four drams of clear serum; the left lobe of the cerebellum was so much destroyed by softening, that it formed one continuous cavity; it contained, however, but a small quantity of pus. The portion of cerebellum surrounding this cavity was much injected, whilst the right lobe of the latter was healthy. The object of the narrator of the case was to ascertain whether any member had observed hemiplegia to be the result of abscess in the brain, caused or accompanied by disease of the bone; he, Mr. Roderick, had never observed this to be the case; in softening, however, independent of disease in the osseous structure, he had known hemiplegia to be a frequent symptom."

stant for two or three years. Latterly the pain became more intense, accompanied with very considerable constitutional excitement. In this state he lingered for some days, and expired in great agony."

"A tumour similar to the preceding. The patient, a middle aged woman, had long laboured under obscure head symptoms, accompanied with occasional purulent discharge from the ear. She was received into the medical ward of R. I., underwent a great variety of treatment without avail, and ultimately succumbed."

The cases of medullary fungus exemplify the fact that the inner ear is liable to malignant disease as other structures of the body. It may admit of question, however, whether these tumours originated in the ear, or extended to that organ from the brain, or the dura mater. Mr. Travers has reported a case of malignant disease implicating the internal ear; but its exact connections he could not discover, a *post-mortem* examination not being allowed.

Theory leads to the expectation, and experience confirms its truth, that these serious evils extend in the majority of instances from the tympanum to the brain; yet it is very possible, and cases occur which seem to prove, that disease of the brain may extend to the tympanal cavity, and that by this means a cerebral or meningeal abscess may find an outlet.

The *Treatment* of chronic Inflammation of the Tympanum is conducted under great disadvantage, as the disease is often so insidious, as to be neglected until extensive disorganization has taken place. Antiphlogistic remedies, modified by the circumstances of individual cases, are to be employed with a view of preventing the affection from extending; when an Otorrhæa is established, experience has shown that it is a dangerous experiment to attempt its removal by powerful astringents, as a metastasis, or an extension of the disease to the brain, is so liable to take place; it will therefore be more judicious to cleanse the auditory tube with the mildest applications; to carefully avoid all excitement, and, for that purpose, to place a little cotton in the meatus, particularly when it is unusually exposed, and carefully to warn the patient

against introducing hard bodies to remove any accumulated matter. The general health is to be especially attended to; and the signs of the disease extending to the brain should carefully be watched for, and on their very first appearance actively met by vigorous treatment.

As the practitioner is not generally consulted upon such a case until after the accession of the cerebral symptoms, it is very likely to be mistaken for idiopathic meningitis; a circumstance of much importance, as the consequential disease would not demand the depletory treatment to the same extent as an original affection would require; and attention should be directed to restoring the otorrhæa which had previously existed, by means of warm fomentations, poultices, &c.

In cases of chronic disease of the tympanum with an ulcerated membrane and mucus contained in the cavity, the Author has found great advantage from gently syringing it with warm water through the Eustachian tube, which, escaping by the external meatus, cleanses the tympanum, and thus prevents the accumulation of pus in the cavity, which, becoming decomposed by the contact of air, may be a cause of inflammation; and in many instances this proceeding is productive of great improvement in hearing. If the use of the syringe should occasion pain, it ought not to be repeated, without great caution; on the contrary, if it give rise to a feeling of comfort in the ear, as well as an improvement in its function, it may be persevered in; and even, perhaps, a slight stimulus may be sometimes used. With a similar view Dr. Burne has recommended the perforation of the mastoid cells, when the bone is not carious, that through the opening injections might be applied; which must be more dangerous and less convenient than the former mode, and not more efficacious, as the fluid readily flows from the catheter through the tympanum into the mastoid cells.

As one example of many, may be mentioned the case of Samuel Benyon, aged thirty-eight, who had fever in March, 1838, from which he recovered; in April "he had a trickling sensation in both ears with tinnitus. This made him probe his ears with a pin, and in a day or two

afterwards they began to discharge considerably. In a fortnight more he nearly lost his hearing." In July the Author found him very deaf, and that he had once been considerably relieved by a discharge of matter and blood from the Eustachian tubes. Upon closing his mouth and blowing his nose in his handkerchief, the air whistled through both ears with a loud report; upon inspection, a large opening was seen in each tympanic membrane. The catheter was passed with great facility into both Eustachian tubes, and warm water injected, which readily flowed into the meatus, mixed with muco-purulent matter; it was immediately attended with considerable improvement both in hearing and general sensations.

This proceeding is particularly applicable when mucus is accumulated in the tympanum, the membrane remaining entire; the mucus being thus diluted, will more readily flow through the Eustachian tube into the pharynx; or air may be injected with the same intention.(*a*)

(*a*) M. Deleau gives a Table of the known lesions of the middle ear which occasion deafness.

FIRST CLASS.

Affections of the guttural orifice of the Eustachian tube, from disease of the pharynx.
- *First Order.* Chronic inflammation.
- *Second Order.* Tumefied and indurated tonsils.

SECOND CLASS.

Diseases of the Eustachian tube.
- *First Order.* Simple obstruction.
- *Second Order.* Chronic inflammation, { without secretion. / with secretion.
- *Third Order.* Stricture situated in the { inner half. / outer half.

Section V.

CHRONIC INFLAMMATION OF THE EUSTACHIAN TUBE.

Although the Eustachian Tube is implicated in the diseases of the tympanum, of which it forms a part, a few additional observations are necessary, inasmuch as this passage is liable to those affections which occur in other mucous canals.

THIRD CLASS.

Diseases of the cavity of the tympanum.
- *First Order.* Inflammation without secretion.
- *Second Order.* Muculent accumulation
  - from obstruction of the Eustachian tube.
  - from increased secretion.

FOURTH CLASS.

Diseases of the membrana tympani.
- *First Order.* Inflammation.
- *Second Order.* Perforation.

FIFTH CLASS.

Complications attending disease of the middle ear.
- *First Order.* Combination of the above-mentioned affections.
- *Second Order.* Diseases of the middle and of the external ear.
- *Third Order.* Diseases of the middle ear and of the labyrinth, of the auditory nerves, and of the brain.

—*Recherches Pratiques sur les Maladies de l'Oreille, &c.*, p. 154.

Plate 15.

Fig. 1.

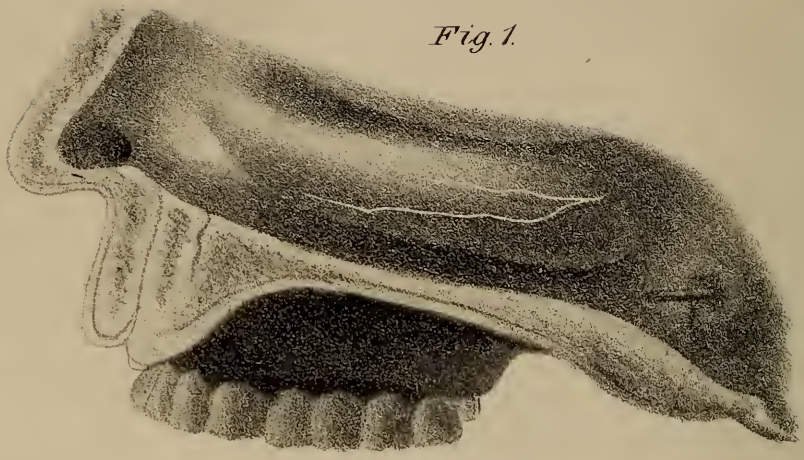
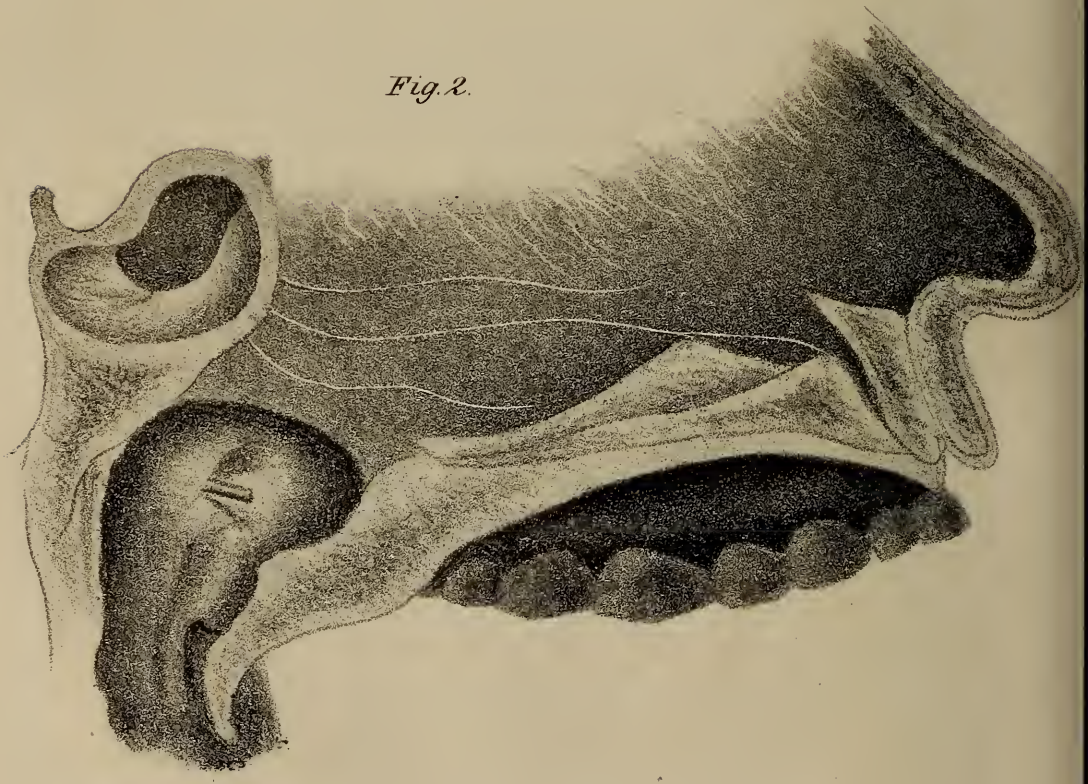


Fig. 2.



Sometimes the mucous membrane of this tube is the seat of inflammation not extending to the tympanal cavity; in which event it usually proceeds from a similar affection of the fauces, and not unfrequently of the tonsils. In this case the lining membrane being turgid, deafness is produced in consequence of the deficiency of renewed air in the tympanum; an uneasy sensation is felt in the back of the throat, sometimes passing to the ear, which is relieved by a discharge of mucous from the tube. In ordinary cases this catarrhal affection soon subsides; in other slight deafness continues, with an excitable condition of the membrane, which is always relieved when a discharge occurs, and thus the anomaly may be accounted for, that in some of these instances a slight coal increases the power of hearing, by giving rise to a secretion, and a consequent lessening of the tumefied membrane; in the greater number of cases, however, such increased action augments the symptoms, by diminishing the calibre of the tube.

The *Stricture* of the Eustachian Tube is a consequence either of acute or chronic inflammation. This term is often applied to every partial as well as complete closure of the canal. It frequently happens that a small quantity of air may be admitted into the tympanum, though insufficient for the purposes of its function; the patient is under these circumstances more or less deaf, and if the contraction of the tube has come on gradually, as often is the case, it may not even be suspected. In these instances the Surgeon must deduce his diagnosis from negative symptoms, as the absence of disease elsewhere, and the

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PLATE XV.

Fig. 1. — An internal view of the Inferior chamber of the Nose, with the mouth of the Eustachian tube, into which a probe is passed.

Fig. 2. — A section of the Face, showing the right side of the septum of the Nose, the hard and soft palates with the Uvula; and the orifice of the left Eustachian tube, with a probe passed through it.

healthy condition of the meatus and membrane of the tympanum, and by the impossibility of the patient forcing air through the tube in a powerful expiration with the mouth and nostrils closed, which will be evidenced by the want of a crackling sensation in the ear, and the incapability of the Surgeon hearing the air rush into the tympanum, or striking against its membrane, either by the aid of the stethoscope, or with his ear in contact with his patient's. The detection of such alteration in the tube is reduced almost to a certainty, by exploring the canal with a sound or catheter, by which it becomes as distinguishable as a stricture situated in the urethra. The deposition causing stricture more frequently arises from scarlet fever or small-pox affecting the fauces, and with them the mouths of the tubes, than from other causes: common catarrh, cynanche tonsillaris, and particularly the spreading of a venereal sore of the throat will often produce this effect; the causes are so frequently and so directly applied, that it is rather astonishing that this consequence is not more common than it is found to be; yet it is certain that the occurrence is not rare, and is very often overlooked.

A gentleman, who had been deaf for several years, in consequence of frequent colds, applied to the Author; he had no uneasiness, but his hearing was so defective, as to render his life almost a burden to himself; he had applied to several so-styled aurists, who had prescribed lotions for the meatus, blisters, &c., without benefit. Upon examination, the outer ear, with the tympanal membrane, was found to be perfectly healthy; he could with difficulty force a little air into the tympanum by powerful expiration, the nose and mouth being closed. Upon passing the catheter into the Eustachian tube, it was clearly shown to be narrowed; air, and afterwards warm water, were with some little difficulty passed through the instrument, but gave rise to the customary uneasy sensation in the tympanum: when the catheter had been introduced several times, it readily passed nearly to the cavity, and while it remained in, and air was admitted through it, the hearing was improved, and continued so for several hours, and sometimes a day or two, when the tube gra-

dually regained its abnormal contraction. The patient has frequent attacks of catarrh, in consequence of his habits and predispositions, which materially interfere with the treatment; he has now for a time been obliged to defer the plan proposed, that, namely, of dilating the tube by mechanical means, and therefore the effects of the treatment cannot be further stated; the prospects of success are, however, encouraging.

The Author frequently sees Jane Edwards, about thirty years old, who has been inconveniently deaf for some years, in consequence of a sore throat while labouring under small-pox; she has several times, with an interval of some weeks, and occasionally two or three months, expectorated some very disagreeable mawkish matter, which gives her the sensation of proceeding "from the back of the throat, high up;" and she believes it to come from the ear, as she always hears better for some time afterwards. She can with difficulty, and that only occasionally, force air into the tympanum. Her auditory canal and membrane are quite healthy. The catheter was passed most readily into the tube, without giving rise to the least pain, or occasioning the loss of a drop of blood; she thought she heard better while the instrument was in the canal, and felt the air, and afterwards the water, which were injected into the tympanum; and she left the Writer with full hopes of obtaining relief. In about five minutes, upon blowing her nose rather violently, the integument of the cheek became suddenly emphysematous, which extended down the neck, producing an appearance something resembling the goitre; it reached the thorax and abdomen, and both upper extremities were especially distended and stiff; the respiration was somewhat interfered with, and deglutition for a few hours impracticable. This emphysema continued for several days, when the air was gradually absorbed, leaving no inconvenience. It occurred to the Author that an old cicatrix in the immediate vicinity of the mouth of the tube must have been broken by the catheter, notwithstanding the instrument passed with unusual facility, and that the air forced into the exposed cellular tissue by expira-

tion in blowing the nose, and which subsequently escaped in breathing, extravasated in the manner described. The unpleasant, and even alarming effect produced in this case, illustrate the necessity of the practitioner observing the greatest care and delicacy in the introduction of the Eustachian tube catheter.

Upon catheterizing the Eustachian tube of Mrs. Eldridge, who, with a healthy external ear, had been long deaf in consequence of small-pox affecting her throat, a slight impediment to the passage of the instrument suddenly gave way and her hearing was immediately improved; of course, frequent repetition will be required to ensure permanent perviousness of the canal.

Mr. D., a medical student, had been frequently the subject of inflammation of the tonsils and fauces generally, which attacks were attended with severe pain, particularly extending through the ears, and which occasioned deafness, increasing after each affection. The Author saw him during one of these attacks, when the agony, which nearly induced delirium, was relieved by antiphlogistic remedies, including free leeching, directed to the throat; it was anticipated that the cause of deafness would require after-treatment. Another inflammatory affection, some months subsequently, while the patient was in the country, left him perfectly deaf on one side, with "a sensation of some discharge passing from the Eustachian tube into the pharynx, and causing a constant inclination to swallow and cough." Many remedies were resorted to unsuccessfully. On his return to town in March last, the Author again saw him, and upon introducing the catheter into the affected Eustachian tube, he felt an impediment, as though a band crossed the canal, which gave way to slight pressure, when the instrument passed as far as usual. The patient's hearing was immediately so perfectly restored, that it was considered unnecessary to adopt any further treatment.

A gentleman of general good health, but of a nervous temperament, had been deaf nearly thirty years, the re-

sult of an inflammatory affection of the throat; he could not force air through the Eustachian tubes; the left meatus and membrane were healthy; the right membrane to a slight degree chronically inflamed, the consequence, most probably, of irritating applications. The catheter readily entered the mouths of the tubes, but required a little force to effect the complete introduction, when air, and afterwards warm water, were, with a little difficulty, thrown into the tympanic cavity. Whilst the instruments remained in the tubes, the capability of hearing was much increased. The occasional dilatation has rendered the canals so pervious, that the patient can readily inflate the tympana, but the faculty of hearing is not proportionately restored in consequence of the torpid condition of the acoustic nerve, depending probably on its long partial disuse.(*a*)

(*a*) Mr. Neil (*Report of the Liverpool Eye and Ear Infirmary*, in Med. Gaz., Oct. 1841) expresses an opinion entirely coincident with that given in notes to pp. 177 and 185. He says: "the most frequent cause of deafness is inflammation and thickening of the lining membrane of the Eustachian tube, and obstructions from morbid secretions; and it is in such cases that the air-press is useful. Granulation, too, similar to the granulated eyelid, will frequently be found to exist, and is an aggravated state of chronic inflammation of the mucous membrane in a strumous habit."

Mr. Pilcher does not direct attention in an adequate manner to the constitutional treatment of chronic inflammation of the Eustachian tube and its consequences. The views entertained on this point by Mr. Neil, are, we believe, those of the most intelligent physicians and surgeons. In reply to the question, — "In what cases do you recommend constitutional treatment, and in what does such constitutional treatment consist?"

Mr. Neil answers: — "When there is a strawberry-looking tongue, a relaxed uvula, enlarged tonsils, enlargement of the glands of the neck, thickening of the lining membrane of the Eustachian tubes, an irritable state of the lining membrane of the nostrils, a strumous habit, and, also, when there is an irritable state of the mucous membranes, I should expect that constitutional treatment would benefit my patient, and assist the mechanical process which I might consider right to use; and my constitutional treatment would consist in blue pill, sedatives, antacids, iodine in

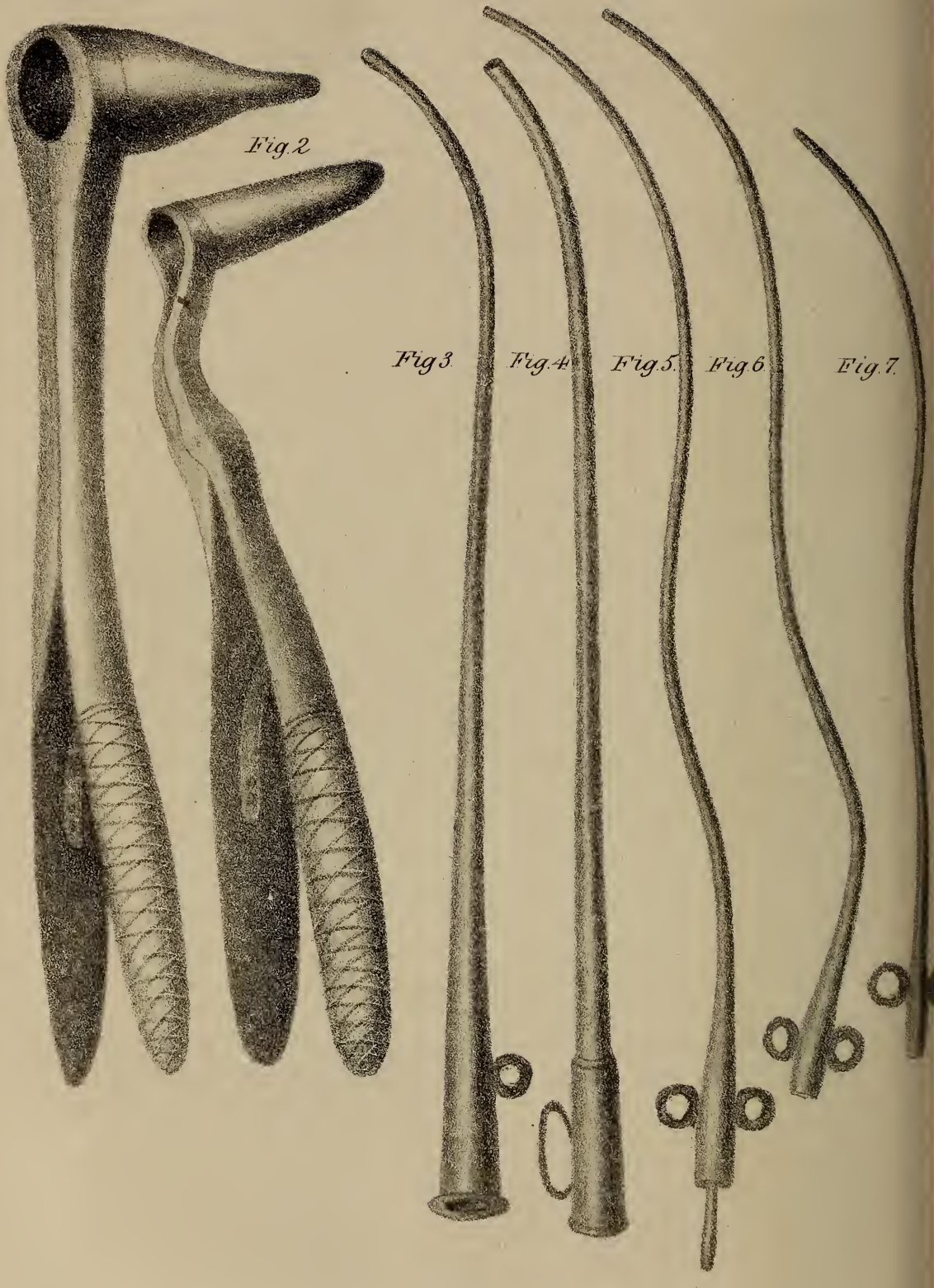
Sometimes the parietes of the Eustachian tube are so firmly adherent as not to admit the smallest instrument, nor the least portion of air; in which case the patient is perfectly deaf of that ear, excepting so far as the sounds may be conveyed through the cranial bones. Such an impervious stricture occasionally occurs from the cicatrization of a specific ulcer, as that following scarlet fever, small-pox, and particularly syphilis. Many cases of this kind are recorded, and several of great interest by Sir A. Cooper in the *Philosophical Transactions*.

The *Treatment* of Stricture of the Eustachian Tube has of late years been much improved, since the important introduction into practice of catheterism of this canal. There are many cases in which the obstruction is so firm as to render this operation quite abortive; but the Author does not hesitate to declare his belief that very many of the so-called incurable strictures will yield to cautious and regular dilatation. When Sir A. Cooper introduced his operation of puncturing the membrane of the tympanum, he was not aware of this procedure; and no doubt can exist, that in many instances in which the membrane was punctured, and in several which this distinguished Surgeon has related, the obstruction might have been removed: and particularly this observation may be applied to those cases where there is a collection of mucus or blood in the cavity, which may be more easily syringed out with warm water through the tube, than removed through an artificial opening in the membrane.

Catheterism of the Eustachian Tube is required for several purposes: — 1st. As an important means of investigating its condition of health or disease, and that of the tympanum — 2d. To remove mucus or blood from the tympanal cavity — 3d. To dilate a stricture of the tube — and, 4th. To stimulate the nervous system of the ear in cases of diminished function.

some of its forms, and afterwards tonic medicines. First I would awaken a new and healthy action in the mucous membranes; and, next, I would endeavour to excite the nervous energy of those and of the contiguous parts."

Plate 16.



The catheter used by Itard is a conical silver tube, curved at the extremity, with a slight enlargement, to prevent it lacerating the membrane (Plate XVI., fig. 3). This instrument is easily introduced, but can be passed only to a short distance into the tube, and therefore is useless as a sound. Kramer has modified Itard's catheter, by making the curve more gradual, and omitting the button point (XVI., fig. 4). Both authors propose to sound the tube by means of catgut run through the instrument; for which purpose, and particularly to inject fluids into the tympanum, it is necessary to fix the catheter by a frontal bandage, which is furnished with a pair of strong holders or forceps. The Author, when he first practised this operation, was desirous to dilate a contracted tube, and therefore gave to his instrument a longer and more gradual curve; the bend near the handle allows it to rest more conveniently against the tip of the nose. This shape was determined upon, after trying a wire, bent in various degrees, upon a preparation of a perpendicular section of the head and face, when that depicted in the sketch (Plate XVI., fig. 5) was found to enter the tube, and to run along nearly an inch of its extent with great ease. A graduated silver wire stylette is also appended to it, which may be introduced beyond the catheter if the Surgeon should deem it advisable, or a catgut string may be used, which, at the same time that it is safer, will answer the purpose as well; and the

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PLATE XVI.

Fig. 1. — Speculum auris used by Kramer.
Fig. 2. — Speculum auris used by Deleau and Itard, and generally adopted in this country (England).
Fig. 3. — Itard's Catheter for the Eustachian Tube.
Fig. 4. — Kramer's Catheter, which is made of various sizes for subjects of different ages.
Figs. 5, 6, and 7. — The Author's Catheters of various lengths (one with a Stylette of Whalebone passed through it).

Author has lately used stylettes of whalebone, slightly enlarged at the point, which he finds much more convenient and useful than when made of other material.

The mode of passing either catheter is nearly the same; the instrument being warmed and slightly oiled, is passed along the floor of the nostril till the point reaches the pharynx, with the convexity upwards, and the concavity downwards; it is then gently turned, so that the point shall be outwards and a little upwards, the mouth of the Eustachian tube being above the level of the floor of the nose; the Surgeon readily feels when the catheter slips over the orifice of the canal. The instrument is then to be gradually carried onwards, until opposed by the narrowing of the tube; in the adult it will frequently occupy three-quarters of an inch of the canal; if the catheter should be forced beyond the fibro-cartilaginous portion, or that part of the tube which readily admits it, the mucous membrane may be lacerated, and pain will certainly be produced. When the instrument is fairly introduced, it will remain without support, by which it possesses considerable advantage over the catheters of Itard and Kramer. As the only difficulty in passing the Eustachian tube catheter consists in turning the point upwards to enter the canal, the Author generally obviates it by carrying the instrument along the inferior meatus of the nose, in the channel formed by the inferior turbinated bone, and the external and inferior walls of the nostril, which may readily be effected without risk of striking the mouth of the lachrymal canal; he directs the catheter obliquely, so that its convexity is upwards and inwards, and its concavity downwards and outwards, hence the necessary rotation is considerably diminished. When used for the purpose of investigation, the wire may be carried further onwards, or what will be much safer, the catgut or whalebone sound may be passed through the catheter. If it should reach the tympanal cavity, it will give rise to pain, often severe, to a loud cracking noisy sensation, extending to the mastoid cells; these feelings will be the more marked in proportion to the healthy state of the tympanum. The Surgeon must be especially careful not to injure the ossicula, the avoidance

of which will require great caution, passing as they do across the cavity; the stylette must therefore just reach the tympanum, without entering it. If the membrane and ossicula are lost, the same caution will not be needed, but in such a case sounding will rarely be required. When air or warm water is injected into the tympanum, sensations similar to those mentioned are produced: and the air may be heard to strike against the surface of the membrane, and to rush through the cavity into the mastoid cells.(*a*)

(*a*) Mr. Neil's directions for the introduction of the catheter into the Eustachian tube are as follows: — "Take No. 8 catheter, as made by Weiss, of the Strand, London; the No. 8 Kramer catheter; it is the one I almost invariably use: stand on the right side of the patient, whose left side should touch a table, on which is the air-press. Stand comfortably on the right side, and put your left hand on the top of the patient's head; hold the catheter between the thumb and middle finger of the right hand — hold it so near to the end at which the loop is, that the fore-finger will touch the open end of the tube: then introduce the beak of the instrument into the nose very quietly. Your hand should be as low as, or a little lower than, the patient's mouth, during the stage of the operation; as you continue advancing the point of the instrument along the very floor of the nostril, continue gently raising the hand, until, when the back of the instrument touches the back part of the throat, your hand shall be as high as the top of the nose, and the catheter itself will be at the upper edge of the nostril. You may then rest for a moment, and it is a good opportunity to chat to those around you, so as to remove any fear from the mind of the patient; he also gets accustomed to the sensation of the instrument in the nose, and will allow you to accomplish the operation easily. You will now bring your left hand round the patient's head, so as to have it in readiness to grasp the catheter when it is rotated into the Eustachian tube, that it may be gently and safely held for the introduction of the air. You will now again take hold of the catheter, touch the back of the throat with it, to be certain that it has reached its destination; then endeavour to make it rotate upwards, drawing it gently forwards until you accomplish this object, which is much facilitated by desiring the patient to swallow; he, in that act, raises the pendulous palate, and removes all obstruction to the entrance of the instrument. I take advantage of this motion always, to pitch in the catheter; when in, in most cases, it will

Deleau introduced the air-douche for the purpose of removing matter from the cavity, and also distending the contracted tube, which Kramer considers a great improvement upon the injection of fluids. Both these intelligent aurists used an air-press for the purpose of increasing and regulating the force employed. The Author, however, daily experiencing the great facility with which air and fluids may be introduced into the tympanum, and regulated both as to quantity and force, by means of a common syringe accurately fitted to the catheter, does not hesitate to declare his conviction that the ceremony and inconvenience of the air-press may be dispensed with. It is of course requisite that the operator should steady the instrument with his left hand while using the syringe with his right. By this means any fluid or gas may be brought into contact with the mucous membrane, and thus stimulate the nerves of the cavity. Deleau uses a flexible catheter, but it does not appear to have any advantage over the silver instrument, and is more inconvenient in introduction. Catheterism will be necessarily often repeated, and continued for many minutes at each time, for the purpose of fulfilling the intentions above stated.

This important operation was first performed by Guyot, a Post-master at Versailles, about a century ago, upon himself, and he succeeded in improving his deafness, though he passed the instrument through his mouth. It is believed, however, that Guyot did not introduce a catheter, but merely scraped the orifice of the tube with some firm body. Itard revived the operation, and very materially improved it. It cannot be requisite to allude to the impracticability of effectually passing an instrument into the Eustachian tube through the mouth, as it is well known that the velum prevents it; whereas, a little expe-

remain if left alone in the passage; and the loop on the outer part of the catheter denotes that the corresponding concave side has its beak also pointed outwards.

"There is no use in having the catheter graduated, unless you could have all men's faces of the same depth. I do the whole process myself; and never allow any one to assist me." — *Ibid.*

rience renders its introduction through the nose one of the easiest of the minor operations in Surgery.

In 1800, Sir A. Cooper introduced the operation of *puncturing the membrana tympani.* The suggestion occurred to his acute mind, that as a large aperture produced by disease or accident, in itself, hardly interfered with hearing, a small puncture skilfully performed would be unattended with inconvenience; and the successful results justified his anticipations.

The operation was immediately tried by many others, but not uniformly with similar success; which is to be attributed to the great *eclat* produced by the innovation inducing many practitioners to employ it in cases where it was inadmissible. The operation is now superseded in many instances in which it was originally used by the catheterism of the Eustachian tube, and appears to be only absolutely necessary in invincible stricture of that canal. Riolanus proposed this procedure long before Cooper, a circumstance, however, of which the latter gentleman was not aware. The operation is easily performed by having a strong light directed upon the membrane, which is then to be perforated at the lower part, anterior to the inferior extremity of the manubrium of the malleus. This is readily accomplished with a small perforator, having a sharpened point extending two or three lines beyond the shoulder. For the sake of security a small trocar and canula have been used, the trocar being capable of projecting only the requisite distance beyond the canula; the sheathed instrument is carried against the membrane, and then suddenly thrust through. The chief objection to this operation is the readiness with which the wound heals, in consequence of which its repetition is rendered necessary. In order to obviate this defect, Mr. Buchanan recommends a quadrangular perforator, which, by making a larger opening, will render the wound less likely to close. Himly has introduced for the same purpose a little punch, which cuts out a small round piece, somewhat similar to the shoemaker's punch, which instrument Dr. Kramer infinitely prefers. Hemorrhage, which occasionally fills the tympanal cavity with blood, is another inconvenience arising from the

perforation, — in most of such cases the blood has eventually escaped through the opening; yet, there is danger of its becoming organized, or remaining there in a clot, and so producing deafness.(*a*)

(*a*) The accidents which sometimes occur in consequence of catheterism of the Eustachian tube, and injections of air into the middle ear, are described by M. Deleau under the following heads: — 1. Inflammation of the throat, and catarrh of the tympanum. 2. Emphysema. 3. Rupture of the membrana tympani. Emphysema has occurred to Deleau six or seven times.

It is probable that the deaths recorded within a year or two past in the *London Medical Journals*, as following the pumping of air from a press into the Eustachian tube, were really owing to its passage into the larynx, by the catheter taking a wrong direction and not having penetrated at all into the tube.

The importance, and, in a great degree, the novelty of the subject in this country, will justify the introduction of the following *Clinical Observations by Mr. Wharton Jones, on the Use of the Air-Douche in the Diagnosis and Treatment of Diseases of the Ear.* (*Lond. Med. Gaz.* 1839.)

No. I. — Circumstances having of late forcibly drawn the attention of the profession to catheterism of the Eustachian tube, and injections of atmospherical air into the tympanum, it behoves every one to contribute what mite of information he may possess, at all calculated to clear away the difficulties or doubts which hang about the subject; for, like most new modes of treatment, considerable misconception prevails regarding it, both as to the principle and performance of the operation, as well as its advantages, — being on the one hand overrated, and on the other underrated.

Carefully observed and faithfully reported cases, it is obvious, are the only means of guiding to a correct judgment. Many cases are to be found in the works of Deleau and Kramer, but they do not record the daily progress of the treatment; for this reason I have thought the following cases, extracted nearly word for word as they occur in my case-book, might be read not without interest. And here I would express a hope that these contributions will be received as they are offered — viz., as imperfect observations on a subject not, indeed, of easy investigation, but by no means incapable of it — a subject which, it is hoped, surgeons will see the propriety of attending to more than hitherto, so as to be able to discriminate what can from what cannot be done, and what it is safe from what it is unsafe to do. In all this we must keep in mind the precept — "Nil fingendum, nil

excogitandum, sed inveniendum quod natura ferat — quod natura faciat."

It is to be premised, that we endeavour to form our diagnosis of the state of the Eustachian tube and cavity of the tympanum on the principle already adopted in diseases of the chest — viz., to hear, when it is impossible to see or touch the disease; the only difference being, that the air producing the sounds in the tympanum is put into motion artificially by the air-douche.

In regard to the air-douche as a means of treatment, all that can be effected by it is the gradual dispersion of any accumulation of mucus which may exist in the middle ear, or the rendering pervious the Eustachian tube, the walls of which have been glued together by thickened mucus.

The eye and ear, though apparently so very different from each other, coincide in many respects both in their structure and in their diseases. As the diseases of the former are much better known than those of the latter, the cautious use of this analogy will be of material service in our examination of the morbid conditions of the ear. Thus, for the sake of example, it may be mentioned that the conjunctiva, that part of the eye which is the seat of some of its most important diseases, is a mucous membrane situated at the peripheral surface of the eyeball. In the ear, some of the most common causes of the derangement of its function depend, in like manner, on the morbid condition of a mucous membrane — that lining the cavity of the tympanum — which, being situated at the peripheral surface of the labyrinth, the essential part of the apparatus of hearing, bears exactly the same anatomical relation to it as the conjunctiva does to the eyeball. Again, the nasal duct, a mucous canal, is the seat of some not unfrequent and very troublesome affections of the eye. The Eustachian tube, which resembles the nasal duct in every anatomical particular, does so also in a remarkable degree in its pathological states. Many more examples might be given of the similarity between the structure and diseases of the eye and ear, but these are sufficient to direct attention to the fact. It is to be borne in mind, however, that in consequence of the difference of conditions required for the exercise of the functions of the two organs, the same elementary form of disease shall have a very different effect on vision and hearing. For example, inflammation and obstruction of the nasal duct has not such a direct effect on the exercise of the function of the eye as the same state of the Eustachian tube has on that of the ear.

In the case of the eye, we can readily remove any accumulation of thickened mucus by means of a sponge and warm water; but the more inaccessible cavity of the tympanum requires to be cleared out by more complicated means. In applying the air-douche for this purpose, or for the purpose of diagnosis, we

ought to go on much the same principle as is followed when it is wanted to blow dust, &c., out of the pipe of a key — viz., give free room for the regurgitation of the air, both where the catheter is inserted into the mouth of the Eustachian tube, and where the nozzle of the tube of the air-press is inserted into the dilated end of the catheter.

But as in catarrhal ophthalmia, for instance, it is not enough to wipe away the discharge from the eye, but also necessary to make some local application to the conjunctiva, if not to employ some general remedy ; so in many cases we must medicate the membrane lining the cavity of the tympanum at least (if we do not think it necessary to adopt any more general treatment), after the accumulated mucus has been removed by the air-douche ; or in the event of no accumulation existing, there may still be a morbid state of the membrane lining the cavity of the tympanum, admitting of being as beneficially acted upon by some local stimulating application as the conjunctiva in chronic conjunctivitis.

It is as simple a matter to put a drop into the eye as to wipe away a discharge ; but in the case of the ear, it is as complicated a proceeding to apply a remedy directly to the membrane lining the cavity of the tympanum as to disperse accumulated mucus. Watery injections are inconvenient in their application, and cause pain. The vapour of acetic ether, admitting of being easily sent in, and exciting no pain beyond a prickling sensation, has been found the best adapted.

The cases which derive advantage from the injection of ethereal vapour, Dr. Kramer considers cases of nervous deafness ; but I believe some change in the membrane lining the tympanum, will, in many instances, be found a more likely cause of the symptoms than any affection of the auditory nerves, as well as the more likely condition to be benefited by the contact of the vapours of acetic ether.

We have, as yet, no correct knowledge of the diseases of the labyrinth. A correct diagnosis, as far as may be, having been formed, of course it is advisable to employ, before or in addition to purely local treatment, leeching, blistering, or whatever other more general remedies may be indicated, the same principles that guide in the employment of general treatment in diseases of the eye, &c., guiding us here.

To place in a striking point of view how far the air-douche serves as a means of diagnosis, and how far as a means of treatment, I take the following calculation from Dr. Kramer's "Tabular view of the frequency and curability of diseases of the ear," remarking that it corresponds with my own, though less extensive, experience here. Out of 300 cases of diseases of the ear of all kinds, 200 in round numbers require the air-douche to assist

the diagnosis, but about 30 only are curable by it. Of the remaining 170, about 30 are put down as cured, and about 50 as relieved, by the injection of vapours of acetic ether; this treatment having been continued for months. Of the remainder, 80 were considered as incurable from the first, and not treated (farther than the exploratory treatment, I suppose); the rest remained rebellious to treatment.

As, in the following cases, admeasurement of the hearing distance by a watch is constantly referred to, it may be well to remark, that the capability of catching conversation is not always in proportion to the power of hearing a definite and equable sound, like that of a watch. The power to follow conversation, is, in fact, sometimes greater than we might suppose indicated by the distance at which a watch is heard; but, on the other hand, it is also sometimes considerably less, and this I have parcularly remarked in cases treated, and so far improved, by the injection of vapours of acetic ether. Notwithstanding this, an approximate conclusion regarding the state of the hearing, sufficient to regulate our diagnosis and treatment, can be made by means of the ticking of a watch, particularly as the sound can be admitted to the ear under examination, always under similar circumstances.

Case I.—Accumulation of Wax in external Auditory Passages.—Obstruction of Eustachian Tubes.—Cavity of the Tympanum free.

A. B., a woman-servant, aged 40.

Wednesday, August 8, 1838. — *Left ear:* Hearing distance by a watch, two inches, with noise in the ear sometimes like a waterfall.

A year last January, the affection came on for the first time, in consequence of cold. The deafness continued for about six weeks, and then went off suddenly. About the end of the following summer the deafness came on again, and then went off as before. Was attacked again in the following winter, but that time the deafness and noise in ear continued three months. The present attack has continued six weeks.

Right ear. — Hears the same watch at a distance of nine feet, ten inches. Had noise in the right ear last year, but not now. The right ear was as bad as the left when first attacked.

Throat a little red, but not swollen. Sense of smell not so acute as formerly, and nostrils rather dry.

Considerable accumulation of dark-brown wax in both auditory passages.

Wax ordered to be syringed out, preparatory to further examination.

Thursday, 9th. — Has had both ears syringed out. The pas-

sage on the right side is now quite clean, and free from any accumulation of wax; but the lower wall, about the middle, has been fretted by the point of the syringe. The membrana tympani on this (right) side, is opaque and slightly yellow; the handle of the malleus, however, can be distinctly seen.

Still some wax in the left passage, so that only the lower part of the membrana tympani can be seen; and this part appears to be in the same state as the membrane is on the right side.

Noise in the left ear entirely gone, but still feels stuffed.

Hearing distance of the right ear, fifteen feet, seven inches; of the left ear, fifteen feet, four inches.

Ordered the left ear to be syringed again, and a solution of the Acetate of Lead (gr. iij. Aq. dest. ℥j.) to be poured into the auditory passages two or three times a-day.

Friday, 10th. — Hearing distance of right ear, thirteen feet, nine inches; of left ear, nine feet, six inches.

Still some wax in left auditory passage, which was ordered to be syringed out again.

A feeling of stuffing, in both ears, proceeding from the nose, as if she could not breathe.

Applied the air-douche to the left side, and found that the air did not penetrate to the tympanum.

To take a little medicine.

Saturday, 11th. — Still some wax adhering to the upper wall of the left auditory passage, but the whole of the membrana tympani can be seen. Has had some noise in the left ear like the singing of a tea-kettle.

Hearing distance of the right ear 10½ feet; of the left ear, 14 feet, 9 inches.

Applied the air-douche again to the left ear, but the air did not penetrate. Applied the air-douche also to the right ear. The air penetrated at first in a small whistling stream, and then with some gurgling, but yet not very freely. Stuffing on the right side a little relieved, but still exists on the left side.

The right ear heard the watch, after the application of the air-douche, at the distance of 17 feet, 9 inches; the left ear at 11 feet, 10 inches.

Monday, 13th. — Left auditory passage is now quite clear. Still some noise in left ear like the ticking of a watch, but not constant.

Applied the air-douche to the left ear. The air now penetrated a little, so that the sensation of stuffing is somewhat less. Applied the air-douche to the right ear also, when the air entered more freely than on Saturday, and with a rushing and gurgling sound.

Hearing distance of the right ear is now 18 feet, 4 inches; that of the left ear is 19 feet, 9 inches.

Tuesday, 14th. — The right ear just hears the watch from one corner of the room to the other (about 25 feet). No stuffing.

Left ear. — Stuffing less; still some noise like the ticking of a watch occasionally. Just hears the watch from one corner of the room to the other.

Applied the air-douche to the left ear only to-day. The air now enters freely with a rushing and howling sound. After the douche, no noise in the ear, nor feeling of stuffing. The heaviness and confusion of the head which she had formerly are now gone. About five minutes after the application of the air-douche, heard the watch with the left ear pretty distinctly from one corner of the room to the other.

Wednesday, 15th. — Has had no noise in the left ear since yesterday. Stuffing very much less. No stuffing in the right ear. Throat and tongue pretty well.

Hears the watch distinctly with both ears from one corner of the room to the other.

To come again on Friday.

Friday, 17th. — Noise in the ears recurred this morning, together with the sensation of stuffing.

Right ear 14 feet, 8 inches; left ear 16 feet.

Applied the air-douche to both sides. There was some gurgling heard in the right tympanum. Some stinging pain felt, more on the right side than on the left, when the air is sent in with any degree of force.

After the douche, heard the watch from one corner of the room to the other, but less distinctly with the right ear than with the left. Noise and stuffing gone.

Saturday, 18th. — No complaint, and hears well. Dismissed, cured.

Remarks. — Though a simple, this is a very valuable and instructive case; and as such, I have chosen it to begin with.

The first thing to be noted is, the coincident accumulations of wax in the external auditory passages, with obstruction of the Eustachian tubes, complete on the left side, and incomplete on the right — circumstances indicating the previous existence of erythematous inflammation of the external auditory passages, and a catarrhal affection of the mucous membrane of the middle ear.

Though the right and the left auditory passages were equally stopped up with wax, the Eustachian tube of the right side was not completely obstructed; hence, perhaps, the cause of the difference in the power of hearing presented by the two ears before the removal of the wax.

But the circumstance which merits particular notice, and which, according to prevailing notions of the physiology of the ear, was not to have been expected, is the great increase of the hearing distance after the removal of the wax, notwithstanding

the existence of obstruction of the Eustachian tubes discovered by the application of the air-douche — obstruction so complete on the left side as not to yield to the air-douche until the third sitting.

The obstruction of the Eustachian tubes appeared to be owing to a glueing together of their walls by thickened mucus. The sounds produced by the entrance of the air indicated a pretty natural state of the cavity of the tympanum; hence the rapid improvement in hearing consequent on the removal of the wax, even while the Eustachian tubes remained obstructed, and the still further and equally rapid improvement, according as the latter were rendered pervious.

No. II. In the case which I related last week, the increase of the hearing power manifested from day to day was a warranty to persevere in the same treatment, until improvement should, under its influence, go no further, or until the cure should be complete. The result was, that the hearing rose to the common natural standard; the means of diagnosis becoming at the same time the means of cure. In the following case, the treatment by the air-douche was persevered in until the hearing on one side was raised to the natural standard, and on the other improvement would go no further.

Case II. — Some affection of the Auditory Passages — Opacity of the left Membrana Tympani — Clogged state of the Tympanic cavities from accumulated Mucus — Eustachian Tubes pervious.

Master C. D., betwixt 12 and 13 years of age, was brought to me by his mother, in the beginning of March, 1838, who stated her son had just been sent home from school, being no longer able to go through his exercises on account of increasing deafness. The deafness, I was informed, had been first observed to come on after the measles, about four or five years ago. Is subject to catarrhal attacks in the nose and throat; has been under treatment without advantage.

The young gentleman could hear my watch with both ears at a distance only of an inch and a half. Thick lips; the nose broad at its root, and the state called epicanthus, *i. e.*, folds of skin extending from the sides of the root of the nose over the inner canthi; together with an habitually loaded tongue and enlarged tonsils, were points in the constitution of the patient worthy of being noted.

On examining the auditory passages, I found them not stopped up, but scales of unhealthy wax adhering to their walls, and projecting into their interior, so as to prevent my obtaining a view of either membrana tympani.

Auditory passages directed to be syringed out every second

night, and a solution of the acetate of lead (gr. iij. to ℥j.) to be poured in two or three times a day.

Mrs. C. D. being anxious that her son should not be kept from his studies, especially as it was now so near the Easter holidays, when he should, of course, be at home for some time, he was allowed to return to school with the above prescription. Under its use the hearing improved so far that the scholastic exercises were gone through without marked impediment, which induced the master to write home, saying his pupil's hearing was restored.

Thursday, April 12. — Has just returned from school, to remain at home during the Easter holidays.

On examining the auditory passages, I found them free; but at one or two places there was a small scab. The membrana tympani of the right side was pretty natural — perhaps only a little red. The membrana tympani of the left side was quite opaque, and presented large dark-coloured varicose vessels streaming through its substance. It was still sensible to the touch of a probe.

Saturday, 14th. — The hearing distance is now eight inches on the left side, and five inches on the right.

Introduced a catheter into the Eustachian tube of the right side, and blowing simply with the mouth, found it admitted the air. The hearing distance was immediately raised to seven or eight inches. The Eustachian tube of the left side impervious to a stream of air blown from the mouth.

Monday, 16th. — In consultation with Sir James Clark. Having stated the results of my examinations of the case, and that I believed there existed an accumulation of mucus in the tympana, which would require the employment of the air-douche to disperse, it was resolved, before having recourse to that, to exhibit some general remedies calculated to improve the state of the mucous membranes. The throat and tonsils being red and swollen, but not affected with any acute inflammation, were ordered to be pencilled daily with a solution of lunar caustic.

Friday, 20th. — Hearing distance on right side nine inches; on left side eight inches.

Sunday, 22d. — Throat improving.

Monday, 23d. — Hearing distance on right side one foot and a half; on left side eleven inches and a half.

On another day in the course of this week the hearing distance had, on the left side, risen to one foot one inch and a half; but on the right side fallen as low as three inches and a half.

Saturday, 28th. — Hearing distance on both sides eleven inches and a half. To leave for school on Monday.

Saturday, 23d June. — Returned from school for the Mid-

summer holidays. Hearing distance of the right ear about six or seven inches; of the left about twelve or thirteen inches.

Has had since last report, while at school, several attacks of ear-ache in the right ear.

To rub tartar emetic ointment behind this ear.

Monday, 2d July. — Hearing distance of the right ear about one foot; of the left ear fourteen or fifteen inches.

Friday, 6th. — Sent in a stream of air, by means of the air-press, through a catheter introduced into the right Eustachian tube, whereupon the hearing distance was raised to one foot eleven inches. Threw in a stream of air on the left side also, after which the hearing distance was increased to one foot eight inches and a half.

During these applications of the air-douche, I found that, on the left side, the air penetrated less freely, and with more gurgling, than on the right side.

The good result of the first essay with the air-douche in this case confirmed the diagnosis I had ventured to draw from my previous observations, especially from the examination made by blowing air through the catheter with the mouth simply, and emboldened me to pronounce a favourable prognosis, qualified only by this — that, considering the extent to which the left ear had suffered from inflammation, as indicated by the opaque and thickened state of the membrana tympani, it was not likely to be so much improved as the right, in which no marked organic change could be detected. This prognosis, though verified by the event, had like to have been contradicted by the unfavourable turn the case took during the three following days.

Saturday, 7th. — Had an attack of ear-ache in the right ear this morning, in consequence of which the hearing distance has fallen to fourteen inches. The left ear, however, has still further improved, viz., to two feet and a half.

Sunday, 8th. — Ordered to day six or eight leeches, to be applied around the right ear; and the tartar emetic ointment, as prescribed on the 23d June, to be continued. Sweet oil to be dropped into the ear, which is to be syringed with lukewarm water at bed-time.

Monday, 9th. — The leeches have been applied, and the cheek is swollen in consequence. No return of ear-ache, but the hearing distance has fallen on the right side to three inches, and on the left side to eight inches.

Introduced a catheter into the Eustachian tube of the left side without causing any pain, and applied the air-douche. The air entered with a rushing sound at first, and on increasing the force of the stream, with a gurgling sound. After this the hearing distance was, on the left side, ten inches.

Friday, 13th. — No longer any tenderness of the ear. Hearing distance on the right side, fourteen inches; on the left side, one foot nine inches.

Applied the air-douche to the right ear, after which the hearing distance was raised to two feet.

Monday, 16th. — Right ear, two feet and a half; left ear, two feet.

Applied the air-douche to the left ear, by which the hearing distance was raised to two feet eight inches.

Tuesday, 17th. — Right ear, two feet eight inches; left ear, three feet.

Applied the air-douche to the right ear, after which the hearing distance rose to three feet nine inches and three-quarters.

Wednesday, 18th. — Right ear, four feet two inches; left ear, two feet ten inches.

Applied the air-douche to the left ear, without any change in the hearing distance immediately resulting.

Thursday, 19th. — Right ear same as yesterday; left ear, three feet three inches.

Applied the air-douche to the right ear. The stream was allowed to be a little more powerful than usual, which caused some pain. A rushing sound was first heard, until the force of the stream was increased, when a gurgling noise became discernible. After the application of the air-douche, the hearing distance of the right ear was found risen to six feet.

Friday, 20th. — Right ear, six feet three inches; left ear, four feet eight inches.

In consequence of some tenderness of the left external ear, the air-douche was not applied to-day.

Monday, 23d. — Tenderness of the left external ear gone.

Hearing distance on the right side, seven feet seven inches and a half; on the left side, five feet eleven inches.

Applied the air-douche to the left ear, and immediately found the hearing distance only four feet eight inches; but on trying it again, in the course of a few minutes it was found to have risen to seven feet and a half.

Tuesday, 24th. — Right ear, seven feet eight inches and three-quarters; left ear, eight feet one inch and a half.

Applied the air-douche to the right ear. When the air enters the tympanum with moderate force, a rushing sound only is heard; but if with greater force, a gurgling noise is perceptible. A few minutes after the air-douche, the hearing distance was found to be nine feet four inches. On trying it again, after an interval of a few minutes, it was found to be almost twelve feet.

Wednesday, 25th. — Right ear, twelve feet eleven inches; left ear, nine feet one inch.

A few minutes after the application of the air-douche to the

left ear, the hearing distance was eleven feet four inches. After an interval of five minutes from the first trial, the hearing distance was found risen to thirteen feet one inch and a half.

Thursday, 26th. — Right ear, fourteen feet three inches; left ear, ten feet and a half.

Applied the air-douche to the right ear. At first there was a gurgling, as if there was in the cavity of the tympanum thin loosened mucus. A rough rushing sound was afterwards heard, as if something vibrated within the tympanum, or as when one blows on a bit of gold-beater's skin, stretched between the fingers. This sound appears to be owing to vibration of the membrana tympani.

Hearing distance on the right side was now fifteen feet and a half, and in the course of five minutes had risen to sixteen feet five inches.

Friday, 27th. — Right ear, seventeen feet and a quarter; left ear, eleven feet eleven inches.

After the application of the air-douche to the left ear, the hearing distance of it was twelve feet five inches.

Saturday, 28th. — Right ear, eighteen feet four inches and a half; left ear, fourteen feet one inch and a half.

Air-douche applied to the right ear. The patient now hears the ticking of the watch distinctly, from one corner of the room to the other, a distance of about twenty-five feet.

Monday, 30th. — Hears with the right ear the watch, from one corner of the room to the other; left ear, fifteen feet and a quarter.

After the application of the air-douche to the left ear, the hearing distance was found risen to about eighteen feet.

Tuesday, 31st. — Left membrana tympani, though still opaque, does not appear so much thickened as before. It glistens more naturally than it did. The handle of the malleus may now be seen. The appearance of the right membrana tympani is pretty natural.

Hears the watch with the right ear distinctly, from one corner of the room to the other. Hearing distance of the left ear, fourteen feet five inches.

After the air-douche to the left ear, the hearing distance was about seventeen feet.

Thursday, August 2. — Hears the watch distinctly with the right ear, from one corner of the room to the other, but did not hear it with the left ear at quite such a distance as the day before.

Applied the air-douche to the left ear without much change, the hearing distance remaining at only about fifteen feet.

Friday, 3d. — Right ear continues good; left ear hears the watch at the distance of sixteen feet four inches.

Saturday, 4th. — Dismissed cured, and is to go back to school on Monday. To guard against a relapse, it was directed, in addition to the general instructions regarding diet and regimen, which were obviously indicated, that in the event of ear-ache coming on again, leeches should be freely applied without loss of time, the ear fomented with warm water, and warm sweet-oil dropped in.

Saturday, 18th. — Received a letter from Mrs. C. D. to-day, in which she says her son is quite as well as when I saw him last; and although he had had a slight cold since, it had not in the least affected his hearing.

Remarks. — In this case, the principal cause of the deafness was accumulation of mucus in the tympanic cavities. There was no particular obstruction of the Eustachian tubes; it merely appears, that at first the Eustachian tube of the left side was impervious to a stream of air blown from the mouth; and that at the first application of the air-douche, the air penetrated less freely and with more gurgling than on the right. That the affection of the auditory passages had some share in the production of the deafness, was shown by the circumstance, that, when they were restored to a more healthy state, the hearing distance was raised a few inches, and the susceptibility to the human voice very much improved; but, unlike what occurred in the preceding case, the clogged state of the tympana prevented improvement to any considerable extent. The increasing ratio in the progress of improvement, under the use of the air-douche, illustrates well both the nature of the principal cause and the efficiency of the means adopted for its removal. That hearing was not so fully restored on the left side as on the right, was owing to the opaque and thickened state of the membrana tympani, and possibly to a similar state of other parts of the ear not accessible to view.

As to the origin of the state of the ears.

The deafness, it is said, was first observed to come on after the measles. Both the eye and the ear, it is well known, are particularly obnoxious (especially in scrofulous constitutions) to what is called the *dregs* of the measles, as well as of the other exanthemata. Ophthalmia tarsi, scrofulous ophthalmia, chronic dacryocystitis, &c. — all diseases involving tegumentary structures, are very often excited by the measles, &c. The accessory parts of the ear being in like manner chiefly composed of the tegumentary tissue, readily participate in the various affections of the skin. In the case before us, I believe we have a counterpart of the diseases of the eye, excited by the same cause. The tegumentary lining of the auditory passages, with the ceruminous glands, were affected. Now this resembles, in many respects, that disease of the eye called ophthalmia tarsi. In both cases the structure affected being a tegumentary tissue in the transition

from skin to mucous membrane; in the one connected with the ceruminous glands, and in the other with the Meibomian follicles.

But in addition to the affection of the tegument of the auditory passages, there was some affection of the mucous membrane lining the cavity of the tympanum, giving rise to the accumulation of mucus; an affection which might be compared to the scrofulo-catarrhal ophthalmia, or to chronic dacryocystitis, diseases, as above mentioned, often excited by measles, and often existing along with ophthalmia tarsi.

This comparison of the pathology of the case under consideration with morbid states of the accessory parts of the eye, excited by the same cause, indicate the propriety of employing the same general means of cure; but, as was pointed out in my former communication, in regard to some parts of the local treatment, what is of easy application to the eye requires a complicated apparatus for the ear.

Unfortunately, cases such as the above have a great tendency to relapse, either in consequence of the membrane — the seat of the disease — not being restored to a healthy action, and thus giving rise to a reaccumulation of mucus, or in consequence of a new attack of inflammation to which the part will continue as liable as at first, or more so. This is not to be surprised at when we reflect on the difficulty of completely curing a chronic conjunctivitis, a chronic dacryocystitis, or even a chronic inflammation of the mucous membrane of the nose and throat; or the liability of these diseases, when cured, to fall back from the slightest causes.

Master C. D. came under my care again eight months after he was dismissed cured, for a renewal of deafness, brought on by repeated attacks of ear-ache while at school. No measures having been taken immediately to subdue the inflammation, the cautions and advice given when he was dismissed having been entirely neglected, the membrane lining the tympanum has, I believe, become much changed in texture, so that the character of the disease is considerably different from what it was before.

The further history of the case will be given along with others treated with the vapours of acetic ether thrown into the tympanum.

No. III. — Case III. Chronic Inflammation of the Lining Membrane of the Tympanic Cavities, with accumulation of Mucus — No obstruction of the Eustachian tubes — Auditory passages natural.

27th Jan. 1839. — The subject of this case was sent by Mr. Quain, of University College, with the following note: —

"My dear Sir, — Mr. E. F., the bearer of this, has been more or less deaf for a considerable time, and, from a short examination, I am inclined to think the Eustachian tubes at fault.

"I shall be much obliged if you will be so good as to examine him and give me your opinion. The tendency of my own opinion is, that the local means — catheterism, &c. — may be beneficial; yet, judging from his appearance, the diathesis, so to say, it is probable they will not alone be of any great utility.

* * * I am, &c.

R. Quain."

Mr. E. F. is 19 years of age; had scarlet fever when he was six; after that the deafness came on. Is subject to attacks of ear-ache. His sister was born quite deaf, but after having scarlet fever she *acquired* hearing!

Skin coarse, with the sebaceous follicles of the face much developed; habitually costive. The climate in which he usually resides is very moist.

In September and October, 1836, was treated in Paris, by M. Deleau, who applied the air-douche about fourteen times, but only with temporary benefit. Took iodine last summer according to the prescription of Dr. Elliotson. During the last autumn, hearing improved of itself considerably, but has been diminishing since he came to London. It is now — left ear, 3 inches; right ear, 5 inches.

Left membrana tympani and handle of the malleus appear natural; the right also. The skin of the auditory passages slightly red and tender. The secretion of wax natural.

Applied the air-douche to both ears, as an exploratory means. On the left side the air entered freely but with great gurgling; on the right side not so freely, and with less gurgling.

After the air-douche, the hearing distance of the left ear was nine inches, of the right ear seven inches. The hearing was further raised on both sides to one foot, by making forced expirations with the nose and mouth closed.

Tuesday, 29th Jan. — In consultation with Mr. Quain, and Mr. Gasquet of Burton Crescent. Hearing distance to day — on the left side, eight inches; on the right side, one foot.

After the application of the air-douche, the hearing distance on the left side was raised to one foot four inches, on the right side to one foot and a quarter.

To continue the treatment with the air-douche, and endeavour to improve the state of the constitution by attention to diet and regimen. To resume the use of the iodine.

Wednesday, 30th. — Left ear, one foot one inch; right ear, one foot and three-quarters. Some pain in the right ear last night, and still some tenderness.

Applied the air douche to the left ear only: the air entered freely.

After the air-douche the hearing distance of the left ear was one foot and three-quarters; that of the right ear, although not treated, was found increased also — from one foot and three-quarters to two feet four inches and a half.

After some minutes, and after having forced air into the tympanum by attempting to expire with the nose and mouth closed, the hearing distance on the left side was raised to three feet, and on the right side to three feet and a quarter.

Thursday, 31st. — Left ear, from two feet to two feet and a half; right ear, three feet. After forcing air into the middle ear, by attempting to expire forcibly with the nose and mouth closed, the hearing distance of the left ear rose to three feet and a half, and that of the right ear fell to two feet and a half.

Applied the air-douche to the right side only. The hearing distance was diminished immediately after, but in the course of a few minutes it was found risen again to three feet.

Tuesday, 5th Feb. — Right ear, two feet and a half, at first trial, but after forcing air into the Eustachian tube, by attempting to expire with the nose and mouth closed, the hearing distance was found raised to four feet.

Left ear, one foot ten inches at first trial; three feet one inch and a half after the forced expiration. Some cold in the head, and tenderness about the external auditory passages. No air-douche to-day.

To apply leeches behind the ears.

Tuesday, 12th. — Leeches have not been applied. Left ear, one foot four inches; right ear, two feet. After a forced expiration, left ear, two feet five inches; right ear, three feet three inches.

Friday, 15th. — Ear-ache has shifted from the right to the left side. Has had some leeches applied behind the left ear.

To repeat the leeches.

Monday, 18th. — Has had ten leeches applied behind the left ear. Still some pain and tenderness of the left ear.

Tuesday, 19th. — No pain, but still some tenderness. Fomented the ear last night with warm water.

To rub in tartar emetic ointment behind and below the left ear.

Thursday, 21st. — Left ear, one foot; right ear, one foot and three-quarters. Still some tenderness of the left ear. Pain is excited when air is forced into the tympanum by attempting to expire with the nose and mouth closed.

Tuesday, 26th. — Right ear, two feet three inches; left ear, two feet one inch. No recurrence of ear-ache.

Wednesday, 27th. — Again some pain in the left ear. Hearing not so good to-day. Nasal catarrh continues.

Friday, 1st March. — Hearing very dull to day ; no ear-ache. Air-douche applied to both sides. The air entered freely, but produced great gurgling. No pain during the application of the air-douche ; but the Schneiderian membrane is so tumid that a very small catheter only can be passed along the nostrils without causing pain.

The cold is now going off ; the mucus is therefore increased in quantity and becoming thicker, hence the greater degree of deafness.

After the air-douche, the hearing distance on the right side was one foot eleven inches, on the left side one foot six inches.

Saturday, 2d. — Right ear, one foot eleven inches ; left ear, one foot nine inches and a half.

Right ear treated. The hearing duller immediately after the application of the air-douche.

Monday, 4th. — Right ear, one foot nine inches ; left ear, one foot two inches and a half.

Left ear treated. Some obstruction to the free entrance of the air at first, but that was readily overcome, and then the air entered freely.

After the air-douche, the hearing distance of both ears was about two feet and a half.

Wednesday, 6th. — Right ear, two feet eleven inches ; left ear, two feet five inches.

Right ear treated.

Friday, 8th. — Does not hear so well to day, but does not complain of ear-ache.

Monday, 11th. — Right ear, one foot three inches ; left ear, one foot.

Applied the air-douche to both sides. After the air-douche, the hearing distance of the right ear was found raised to two feet and a half ; of the left ear, to one foot eight inches.

Tuesday, 12th. — Right ear, two feet and a half ; left ear, two feet.

Left ear treated. During the injection of the air, felt a sudden pain in the situation of the mastoid cells.

Wednesday, 20th. — Right ear, one foot four inches ; left ear, only seven inches.

Air-douche applied to the left ear — great gurgling.

Thursday, 21st. — Right ear, one foot ; left ear, one foot nine inches.

Air-douche applied to the left ear to-day again, the right nostril being too tender to allow the catheter to pass. During the application of the air-douche felt a sudden pain, as on Tuesday, the 12th.

After the air-douche, the vapour of acetic ether, diffused in air, was allowed to flow gently into the tympanum.

After this treatment by the air-douche and ethereal vapours, the hearing distance of the left ear was two feet and a half.

Friday, 22d. — Hears well to day, but has not time to be treated.

Monday, 25th. — Right ear, four feet one inch; left ear two feet seven inches.

Right nostril still too tender to admit of the introduction of the catheter.

Left ear treated by the air-douche and ethereal vapours. After this treatment the hearing distance was three feet four inches.

Tuesday, 26th. — Right ear, three feet seven inches. Left ear, one foot eight inches.

Left nostril so tender as not to allow of catheterism to-day. The tonsils and uvula red and swollen. The mucous membrane of the nose also red and swollen.

To apply a leech within each nostril, and to take a dose of jalap and rhubarb.

Wednesday, 2d April. — Right ear, one foot nine inches. Left ear, two feet.

Left ear treated.

Monday, 8th. — Right ear, two feet three inches. Left ear, three feet six inches.

Right ear treated. After the treatment heard the watch at the distance of six feet.

Wednesday, 10th. — Right ear seven feet three inches. Left ear, three feet four inches. Left nostril too sensitive to allow the passage of the catheter.

Right ear treated by the air-douche and the ethereal vapours.

Friday, 12th. — Right ear, seven feet and a half. Left ear, one foot and a quarter.

Left ear treated. A pricking sensation felt in the ear, from the ethereal vapours.

Has heard, yesterday and to-day occasionally, sounds like the beating of a hammer.

Monday, 15th. — Right ear, seven feet six inches. Left ear, 4 feet ten inches.

Has not heard the beating since. Right ear treated.

Friday, 10th of May. — Has been in the country since the last report.

Right ear, 9 feet, 2 inches. Left ear, 7 feet, 5 inches.

The hearing having improved so much of itself while in the country, I thought it advisable not to pursue the local treatment any further, but to wait and see what the powers of nature would do.

I have seen this patient twice since, when he complained that his hearing was becoming dull again.

Remarks. — The result of this case has in some degree justi-

fied the anticipation of Mr. Quain. The scrofulous diathesis, with an unhealthy state of the tegumentary system in general, evident in this patient, was a great obstacle to permanent improvement. As in Case II., the disease of the ear was called into existence by an exanthema. It appeared to be confined to the middle ear, the mucous membrane of which was in a state of chronic catarrhal inflammation, alternately calming down and becoming aggravated. All that the air-douche appeared to do when applied by M. Deleau, as well as when I applied it, was to effect the dispersion of the accumulated mucus, and so improve the hearing for a time. The affected membrane, however, not being at the same time restored to a healthy action, the mucus was always re-accumulating; hence the constant tendency to relapse, and the comparatively small progress made by the treatment above recorded, until the membrane lining the tympanum was directly acted on by the vapours of acetic ether. After this, the improvement was more striking than before, and probably, if it had been persevered in, decided and permanent advantage would have been ultimately gained.

A point worthy of notice was the improvement in the hearing effected by forcible expirations with the nose and mouth closed. It has been long known, that by making a forced expiration with the nose and mouth closed, deafness is in some cases considerably relieved. With such facts, Deleau remarks, it is surprising that blowing air artificially into the tympanum in deafness was not thought of sooner. Archibald Cleland spoke of blowing air into the tympanum a hundred years ago, but his was a mere suggestion, and I do not find that he meant the air should be sent in by any other means than by the operator blowing with his mouth through a flexible tube (the ureter of a large animal) attached to the catheter introduced into the Eustachian passage.* When the hearing is improved by merely forcing the breath through the Eustachian tubes into the tympanic cavities, it is in general a sign promising farther advantage from the air-douche. In recent cases of muculent obstruction of the tympanic cavities, without obstruction of the Eustachian tubes, very considerable improvement may in this way be obtained, as in the following: —

Case IV. Friday, 26th April, 1839. — Master G. H. aged

* Wathen's cases by aqueous injections are well known. Busson (an absque membranæ tympani apertura topica injici in concham possint. Paris, 1784. Haller, Collect. Diss. Chir. t. 2, p. 286) proposed to effect the discharge of fluids effused into the cavity of the tympanum by forcing vapours into the Eustachian tube. His proceeding was to fill the mouth with the vapours, close the lips and nose, and then make a long forced expiration, by which the vapour is driven through the Eustachian tubes into the tympanum.

about 14. Hears the watch at the distance of nine inches on either side. The deafness has been occasional in occurrence for some time, and varied in degree. Has had sore throat lately, but is now better. The tonsils are somewhat enlarged, and the uvula long. A rather too copious secretion of wax, which appears at the very entrance of the auditory passages, though it does not stop them up.

On making the patient expire forcibly with the nose and mouth closed, the hearing distance was raised on the right side to four feet nine inches, and on the left side to five feet seven inches.

If the obstruction be of some standing, such an event does not so readily take place, but that more or less improvement may be obtained by it is shown in Case III., and Dr. Sims (*Memoirs of the Medical Society of London*) mentions a case in which forcing the breath into the Eustachian tube, with the nose and mouth closed, proved successful after the deafness had continued for more than a year.

The subject of Case III. took iodine, though not with any marked advantage. This medicine was first employed in deafness by Dr. Manson, of Nottingham, who however gave no particular diagnosis for the cases in which it proved useful. But as he also succeeded in curing chronic dacryocystitis by the same remedy, I am inclined to think that in Dr. M.'s cases the deafness was owing to affection of the mucous membrane of the middle ear, especially as I have shown that the membrane lining the tympanum and Eustachian tube, and that lining the lacrymal sac and nasal duct, strongly resemble each other, both in their structure and in their diseases. It is in children, however, and at the commencement of the complaint, that iodine has most influence in diseases of the ear.

In the course of Case III. it is several times mentioned that the hearing was diminished immediately after the air-douche: Dr. Kramer considers this a positive sign of nervous deafness. Whether it be so or not, the state of the middle ear in this patient was sufficient, in my opinion, to account for all his deafness, and the improvement gained from the application of the ethereal vapours bore too strong an analogy to the speedy and marked improvement, derived from a stimulating application in chronic catarrhal ophthalmia, to induce me to look deeper for a part which might be supposed to be that at fault, and therefore the one benefited by the remedy.

CHAPTER III.

ON THE NERVOUS DISEASES OF THE EAR.

These affections may be arranged under two heads: first, *Disordered Function of the Acoustic Nerve;* and, second, *Disordered Function of the Nerves of common Sensibility and Motion*, or of the *Tympanal Nerves*, as they may be termed, being contained for the most part in that cavity.

The first division includes the only diseases of the labyrinth which Dr. Kramer can recognize as such. How far this may be correct we have already seen.

The functional derangements of the auditory nerve, so termed, because the disturbed actions do not arise from any appreciable organic change in the structure of the nerve, may be caused by various circumstances; for instance, disease and injury of the brain, affections of the middle ear, or of the neighbouring structure, may and do excite imperfect action in the nerve, without producing diseased structure which can be recognized by the anatomist. But as in these cases the altered function is merely a symptom of organic disease in the vicinity, it is very properly not treated in itself as an abnormal condition. The nerve, in some part of its course, and perhaps through the whole extent, or more likely at one of the extremities, undergoes such an alteration in action as to give rise to a serious train of symptoms. It is probable that in all cases there exists some change in structure, though too minute for detection, either in the nerve, or the part of the cerebral mass with which the nerve is attached, but when, as so frequently happens, such change cannot be demonstrated, it would be unphilosophic to consider it as a fact, however much we may be inclined to suspect its real existence. That the nerve undergoes organic change from disease has already been shown.

The *functional derangement* of the auditory nerve has been correctly divided into two states: the *Erethitic* or *Excited*, and the *Torpid*. The former may be called the acute, and the latter the chronic form; these two condi-

tions, indeed, frequently stand in relation to each other of cause and effect, resembling so far acute and chronic inflammation.

Section I.

The *Irritable* condition of the nerve generally arises sympathetically, either with the general health; and frequently from an over-plethoric habit; with disease of the tympanum especially; or with some local affection; thus it may sympathise with a disordered brain, stomach, bowels, uterus, &c.; it often occurs from over-use of the organ, in the same way as the retina loses its susceptibility to healthy impressions, and becomes abnormally excited from over-action; it is also a very common attendant upon fever during the stage of excitement. This affection, however, frequently arises without any evident cause, although a latent one may still exist.

The patient is much annoyed by sounds in his head, a tinnitus aurium, which the patient compares to various noises, such as the ringing of bells, roaring of waves, buzzing of insects; these sounds are at first usually grave and afterwards acute, frequently preventing sleep, — he is deaf on the affected side, often to a considerable extent. One of the most annoying symptoms is a pulsation in the ears, synchronous with the heart's action, more or less constant, and always much augmented by mental excitement or bodily fatigue. The Author frequently sees a gentleman whose existence is made miserable from this cause. These unpleasant sensations shift from side to side; and though they almost always begin in one ear, frequently terminate by affecting both.

At other times the affection commences and proceeds more gradually; the hearing being impaired, and the above sensations produced, only when listening to minute sounds, which circumstance may be forgotten until the disorder becomes more severe. These symptoms are increased by circumstances affecting uncomfortably the mind or body, and are lessened by quietude, cheerfulness, and improvement of health. It has been particularly

noticed by Sir A. Cooper, and confirmed by many others, that the meatus externus is dry, the secretion of cerumen being lessened, by which the patient's annoyances are increased.

The disease proceeds to such an extent as to incapacitate the sufferer from attending to his avocations, and it may exist for many years, or even during life. In severe, and long continued cases, otalgia is sometimes excited, which extends to the surrounding muscles and skin.

A curious circumstance is connected with this affection; the patient can sometimes hear the human voice and hold a conversation, when the surrounding noise is very great, as in a carriage, or walking along a noisy street, whereas without this loud accompanying noise he would be deaf to the slighter sound. Various reasons have been assigned to account for this phenomenon, such as the relaxation of the membrane, or the tenser tympani; it most probably, however, is owing to the nerve roused into action by the loud sounds, being then enabled to appreciate those more minute; if, indeed, as appears probable, it is not altogether ideal and depending upon the circumstance of the healthy individual raising his voice to overcome the noise which confuses his audition, and which only being partially heard by the deaf person, he distinctly recognises the elevated and clear speech. The different shades of hearing, are only symptoms of this affection, as the Hypercusis, Paracusis, &c.; thus again it bears among many other particulars a resemblance to amaurosis. The disorder frequently terminates in incurable torpor; and therefore requires a guarded prognosis.

The *Treatment* consists in removing if possible any general or local disease which may cause or keep up the affection. When attended with general excitement that must be combated; but if, as the Author's experience leads him to believe is more usually the case, it is consequent upon general debility, or nervous excitability, it will be more readily relieved by such remedies as tend to their improvement; such as quinine, and other tonics which may be considered most applicable to the indivi-

dual case, together with mild opiates, carefully regulated diet, change of air and scene, warm sea-bathing, &c. As this affection so nearly in its character resembles amaurosis, it is a question if the effects of mercury, which in the latter instance are often found to be of such marked benefit, might not sometimes be attended with advantage. In some cases the introduction of ætherous vapour into the tympanum, in the manner presently to be described, has been attended with benefit, in conjunction with general treatment. Such applications must be adopted only in long continued affections, when they have somewhat assumed a chronic form; as in the earlier stages the stimulant may be injurious. Counter-irritants in the vicinity of the ear, and especially blisters behind the auricle are found to be important assistants in removing this distressing malady. A mild stimulating application, as the citrine ointment diluted in the manner already noticed, the weak solutions of zinc, of nitrate of silver, of bichloride of mercury, may be applied with advantage to the meatus, with the hope of promoting the ceruminous secretion.

Section II.

The *Torpid Functional Derangement* of the auditory nerve is generally the disease of old age, and is the usual, but not the only cause of deafness at that period; for it is also probable that the other structures of the ear may undergo a change consequent upon long continued use, and lessened energy of nutrition.

This form of functional disorder arises in persons of all ages, and is probably sometimes the cause of congenital deafness. It often follows the over-excitement of the function; and it is most likely this circumstance, which gives rise to the opinion that the ear-drum is broken in consequence of the roar of a cannonade, or the breaking of stones, or any loud noise, either suddenly applied, or long continued.

When it occurs in old age, the affection comes on so very gradually, as to exist often many years before the

hearing is entirely lost; whereas in younger persons it is generally preceded by an erethitic state of the nerve. Concussion of the brain arising from a blow upon the head, may also be followed by deafness, from this torpid state, more or less complete, and more or less permanent It likewise is a frequent attendant upon typhus fever after the stage of excitement has passed away, and may be then considered a favourable symptom as indicating a diminished energy of the general nervous system from which the patient usually recovers; not unfrequently, however, this hardness of hearing continues after the subsidence of the fever.

This state of the nerve is ascertained to be the cause of the accompanying deafness, by the absence of disease in the external and middle ears, which require, therefore, to be carefully investigated both by the meatus and the Eustachian tube, — by the want of perception of sounds when the bones of the cranium are thrown into vibration, by the watch placed upon them, or between the teeth. This torpid condition is generally accompanied by some tinnitus aurium, even when it is not preceded by the erethitic state. In making his diagnosis the Surgeon must be careful to distinguish between the sense of feeling and that of hearing, for the reasons stated in a former part of this Essay.

The *prognosis* of this affection is usually unfavourable; yet, Dr. Kramer in particular has related some cases of successful treatment, and if future experience should confirm his results, his practice must be esteemed as a great improvement in aural Surgery.

The general health of the individual demands the chief attention, and if the disease arise from sympathy, the original malady must be first improved before we can hope for much success from our remedies. The various nervous excitants have enjoyed their temporary fame, as galvanism, electricity, &c., but have failed to maintain their empirical reputation. Itard first introduced through the catheter into the tympanum ætherous vapour, generated by dropping the fluid on hot iron; and Dr. Kramer has, in the same manner, passed the acetous æther, vaporised by the heat of the room, into that cavity,

which being milder than the vapour, is not productive of any ill consequences, and in his opinion is more effectual.

For the purpose of introducing the vapour, Kramer uses a glass jar, to the mouth of which is accurately adapted a cork, through which are passed two metal tubes, one being furnished with a funnel and stop-cock, for introducing the fluid, the other with an elastic tube and stop-cock; the jar being half filled with warm water, a small quantity of the acetous æther is introduced through the funnel, which is immediately closed by the stop-cock; the elastic tube being then fitted to the catheter, previously introduced into the Eustachian tube, and then opened, the æther vaporised, rushes through the tube into the tympanum, sometimes as the Writer has experienced, with an audible sound, at others producing but little effect. The Author continually uses a wide-mouthed bottle, through the cork of which a metal pipe is passed in an air-tight manner, which pipe is furnished with an elastic tube and stop-cock. The bottle being half filled with warm water, about half a drachm of acetous æther is poured into it, and the mouth is immediately closed; the little apparatus being very portable, the elastic tube, with its stop-cock, is readily attached to the catheter, already passed into the Eustachian tube, and the vapour is then allowed to flow into the tympanum. As it frequently happens that the vapour does not pass over by these means, probably in consequence of the æther combining with the water, the Writer often places the bottle containing about a drachm of the fluid, in a jug of warm water, when in a few seconds the æther is rapidly vaporised. He has not met with the inconvenience of over-stimulus arising from this plan, to which Dr. Kramer has alluded. This vapour may be applied two or three times at a sitting, which may be repeated daily, or every two or three days, according to the effect produced. When this stimulant does not seem to be sufficiently active, a very diluted mixture of the acetous æther in water, about a drachm to half a pint, may be injected into the cavity of the tympanum with frequent benefit. This proceeding, however, must be conducted with great cau-

tion, as the Writer has seen it produce considerable pain, and it may excite inflammatory action. The patient's deafness is generally increased for a short time, varying from a quarter of an hour to a day or more, after the injection of the gas, and more particularly of the fluid, in consequence of the distension of the tympanum interfering with the vibration of its membrane. The following case exemplifies the good effects occasionally derived from this plan of treatment, although justice requires it to be stated, that the Author's experience does not warrant him in being so sanguine of the general result, as Kramer's asserted success would justify; yet it must be admitted, that if only one case out of many which have been deemed incurable is restored to hearing, this plan, introduced by our Continental neighbours, must be esteemed as a most valuable boon to humanity.

The Rev. W. I. H. states, that "at the age of sixteen my sense of hearing was severely injured by a succession of violent inflammatory attacks in my ears. About thirty-four years have elapsed since that period, and, during all that time, I have been almost entirely deprived of the use of my right ear, and have had but an imperfect use of my left. On various occasions, when labouring under bodily indisposition, I have been afflicted with almost total deafness, which has sometimes continued long after the indisposition itself had ceased. In the course of last winter I was afflicted by a severe and obstinate attack of quinsy, which, as usual, very much affected my hearing. The deafness occasioned by its continuing some months after my recovery from this attack, I was strongly urged by my kind medical attendant to submit my case to the inspection of Mr. Pilcher, which advice I followed, and soon began to experience surprising benefit, particularly in my right ear, which, for the greater part of my life, had been almost entirely useless. During the few weeks I have been under treatment, a gradual improvement has been effected, to which I am indebted for the perfect recovery of my hearing, and a consequent augmentation of the happiness of life."

The treatment pursued in this case was the application of the vapour of acetous æther two and sometimes three times a week, the patient's avocations not permitting the more frequent use of the remedy; when the vapour did not produce a sensible effect, the much diluted mixture of æther and water was injected. The right ear only has been sufficiently operated upon to produce any influence, as, in consequence of a diseased condition of the mucous membrane of the left nostril, it is at present difficult and somewhat painful to pass the catheter. The lining membrane of the external ears of this gentleman is dry and scaly; the Eustachian tubes are large and pervious, and the symptoms denote a torpid condition of the acoustic nerve, attended with occasional tinnitus aurium.

Cotton, soaked in some gentle stimulant, has been applied to the auditory canal, and it is supposed with occasional benefit in exciting the follicles to action.

It must never be forgotten that the use of the nerve being long neglected, it runs into a state of torpor, from which it will be difficult to restore it; thus, a gentleman deaf from an injured membrane, neglected to use that ear until he believed it had lost all sensation; but, becoming deaf on the other side, he found he could hear slightly on that originally affected, and by great perseverance, at length heard tolerably well. Hence also this non-use of the nerve may become a cause of deaf-dumbness, the child being hard of hearing from some cause, congenital or acquired, the lessened faculty is altogether neglected.

Section III.

The Functional Derangement of the Tympanic Nerves, constitutes the true *Otalgia*, or *Ear-ache*. Kramer does not allude to this affection: but every one must have noticed, and most persons have felt, that the ear is liable to be affected with neuralgia, in a manner resembling such attacks in other organs of high sensibility; indeed, this structure seems more frequently than others to be

thus influenced; and when we call to recollection the tympanic plexus of nerves and its distribution, the chorda tympani crossing the cavity with its connexions, and the close vicinity of the portio dura, our astonishment would be rather excited by the absence than the occasional presence of such a painful affection. The common causes of neuralgia operate here as elsewhere; the most frequent being sympathy with other affections; and the application of cold. Thus, one of the most dreadful concomitants of a diseased tooth is the severe pain shooting through the ear. No Surgeon can have applied a ligature around an enlarged tonsil, without his patient immediately affording signs of suffering from otalgia, which is generally renewed upon every motion of the gland; this affection is also a common attendant upon Cynanche Tonsillaris, independently of the pain excited by the extension of the inflammation along the Eustachian tube. A few years ago the Author was induced to suspect the existence of an enlarged tonsil, from the circumstance of neuralgia of that side of the head and ear: an examination confirmed his suspicions, and the painful symptoms subsiding upon the removal of the gland, the correctness of the diagnosis was made apparent. Any disease in the neighbourhood, whether in the bones, or in the brain or face, may be the cause of the painful ear. Otalgia appears to be especially liable to be suddenly excited by the application of a gust of cold air to the tympanic membrane, and hence arises the common dread of unduly exposing the ears; that a sharp pain exists, indicating an inflammatory state of the tympanum, which is often unfortunately too lightly considered, has already been seen; but every observer must have noticed, that this symptom of acute pain in the ear, often amounting to agony, with increased sensibility of its faculty, occurs so immediately upon the application of its cause, as to render it impossible to be produced by vascular reaction; and again, it sometimes as rapidly subsides, either consequent upon the use of anodynes, or without their assistance; it is, however, frequently a precursor of serious mischief. Neuralgia of the tympanum or its membrane, is sometimes excited by direct injury, as sounding the membrane, to ascertain its state of

health; the too forcible propulsion of water against it in syringing; the introduction of foreign bodies, and the attempts at their removal.

As in all neuralgic affections, the pain varies from a slight uneasiness to complete agony, producing delirium, the extent depending upon the general and local predispositions, and the cause; usually there is a continued aching pain, with occasional sudden lancinating shoots through the ear and the neighbouring parts, particularly taking the course of the lower jaw and upper part of the neck; this increased pain generally arises from a renewed cause, as mental emotion, or sound of cold air striking the membrane, or sudden movement of the head; but it frequently occurs without any evident excitement. Otalgia is distinguished by the pain, and increased sensibility, which frequently produces tinnitus aurium of various degrees and shades, and particularly by the absence of the symptoms of other diseases. The diagnosis, it must be confessed, is sometimes difficult, inasmuch as the painful state of the organ often precludes an accurate investigation, and the affection itself may be merely a symptom of other disease. The frequent recurrence of neuralgic affection may in time produce organic lesion, either in the nerves affected, or their neighbourhood.

The *Treatment* must be that which experience has shown to be most efficacious, when the disorder is seated in other nerves; namely, removing the exciting cause, if one should exist, improving the general health, and exhibiting tonics with opiates. When however the pain is severe, more active remedies are required than these general allusions seem to warrant; thus, full opiates should be administered by the mouth; and the introduction of opium into the meatus will generally be attended with marked relief; and with this view cotton or wool soaked in laudanum and water warmed, a soft suppository of opium and gum or soap, or oil and laudanum, may be passed into the canal; narcotic poultices and fomentations are valuable adjuncts applied to the external ear and side of the head. Purgatives are generally indispensable, both to remove any abdominal irritation, which is a frequent cause of this nervous disorder, and as a prophy-

lactic means to prevent that inflammation which, it is to be dreaded, may succeed; and with this latter view, depletion, by means of leeches applied to the vicinity of the ear, will often be advantageous.

Possibly a torpid condition of the tympanic nerves may exist, either as a consequence of over-excitement, of injury, of old age, or of general disorder; this state may affect the whole nervous system of this structure, or be confined to a portion only, as to the excito-motory, the sensiferous, or the volition fibrils. If such a condition exist, a paralysis of the muscles of the tympanum must be a consequence, and possibly also the vibratibility of the membrane would be diminished with its sensibility. If this supposition be correct, it would seem to be capable of explaining phenomena which are now inexplicable; as some of those of partial hearing, related by Dr. Wollaston; and the result occasionally produced by direct or indirect injury; thus, for example: —

A gentleman, in consequence of a fall from his horse about four years ago, received a violent blow, which produced concussion of the brain, and general ecchymosis on that side of the head; which symptoms having continued for a few days, gradually subsided, without evidences of inflammation, or lesion of any kind, but he has ever since continued perfectly deaf on that ear. Upon examination the Author can discover no cause for the loss of function; the auditory meatus and membrana tympani possess normal appearances; the Eustachian tube is pervious and otherwise healthy; readily admitting the injection of air and of water into the tympanum, which strike audibly against the membrane: the ticking of the watch is distinctly heard when placed in contact with the head, face, teeth, or with the ear; but when held close to the auricle without being allowed to touch it, the sound is quite inaudible. As the labyrinth performs its function, it is a fair presumption that the disorder is confined to the tympanum. — May not a torpid condition of the tympanic nerves exist; or, is it possible that a displacement of the ossicula may be occasioned by the injury received?

CONCLUSION.

From the foregoing pages it will be learned, that the variation in the extent of Deafness is almost infinite; — from the slightest possible, hardly perceptible, deficiency in function, to its complete loss, in which the loudest sound excites no effect, except through the medium of vibration. This variation in function is in part only regulated by the amount of disease of the Ear; the Author daily witnesses cases in which the extent of Deafness, and disorganization of structure, by no means correspond; the membrane and four ossicles of the tympanum have been lost by disease, and yet the sense of hearing was so little impaired, as not to be recognised by ordinary observers. On the other hand, a collection of mucus in the cavity of the tympanum, the effect of mere catarrhal inflammation, the organ being otherwise quite healthy, has produced deafness so complete, as to occasion a consequent dumbness.

These facts in many instances may be accounted for by the circumstance of the various undulations being transmitted directly across the diseased tympanum to the membrane of the fenestra ovalis — or to the stapes or incus as the case may be — in extensive disease of the middle Ear, exciting to action the healthy labyrinth; whereas an interruption to the vibration of the tympanic membrane, or to the oscillations of the bones, will prevent the influence of sound upon the internal Ear; hence the varying accumulations of mucus or muco-pus, in diseases either slight or extensive of the tympanum, produce great and sometimes sudden variations in the power of hearing. The frequent non-correspondence in the loss of function of hearing with the apparent disease, is often attributable to the difference in the impressibility of the auditory nerve; the augmented capability to receive impressions slightly communicated, is remarkable in the labyrinth when the tympanum has been early destroyed; the Surgeon has often to observe a tympanum lost as regards its function with but little imperfection in hearing. A medi-

cal practitioner, who applied to the Author in consequence of extreme deafness in one Ear from diseased nerve, was naturally astonished when informed, that his supposed healthy Ear, with which he heard correctly, had the membrane and bones of its tympanum removed by disease, and that the membrane of the oval fenestra was exposed.

The variations in the capability of hearing different sounds are curious, and perhaps at present unaccountable. Thus, a gentleman, with whom the Writer had been in occasional communication, without detecting his deficiency in hearing, was incapable of hearing the watch when applied to his Ear, though he rarely lost a word in conversation carried on in the ordinary tone. On the contrary, another, deaf from diseased brain, implicating the auditory nerve, is incapable of hearing the voice, even when raised to a considerable pitch, yet can distinguish the sound of the watch at some little distance. Again, an amateur performer on the flute hears the flat notes as naturals, and thus the tune which is harmony to others is discord to him, and the reverse. These peculiarities, probably, in most instances, depend upon some condition partially affecting the acoustic nerve in its expansion; but they also lead to the supposition that different parts of the auditory apparatus are more readily influenced by peculiar sounds, and seem to confirm the observations previously made when discussing the physiology of the membrana tympani.

It is probable that the deafness in the *sourd-muet* is rarely complete, the malformation of the organ being only to a degree; and it is certain that in many cases the partial audition may be much augmented by assiduous and well-directed exercise. Experience, however, justifies the belief that from acquired disease the sense is occasionally totally lost, which most frequently occurs in instances of paralysed or diseased nerve, the affection usually being concomitant with that of the brain, and the latter recovering, leaves the Dysecœa as the prominent symptom or result.

The *causes* of the various degrees of deafness are arranged under the two heads of *congenital* and *acquired.*

The congenital causes of deprivation of this important function, or the malformations of the Ear, we have seen to be most frequently recognised in the labyrinth, in which either the semicircular canals, or the cochlea, or both these structures, have been only partially developed. The situation of the membrane of the fenestra rotunda has been found occupied by bone. The membranous labyrinth has been deficient; and the liquor labyrinthi has presented abnormal constituents or quantity. The auditory nerve, also, in its expansion or its tract, has been imperfectly formed.

The malformation less frequently exists in the tympanum, and when there it is usually accompanied by a deficient formation of the labyrinth.

The abnormal conditions of the middle Ear, so generally detected in the sourd-muet, are often, if not usually, the effect of struma, and in most instances supervene upon the original deficiency of structure in the labyrinth; a circumstance which corresponds to the well-ascertained fact, that deaf-dumbness is almost invariably confined to individuals of a scrofulous diathesis. As an exception to the above observation, it has been noticed that the ossicula are malformed without abnormal arrangement in other parts of the organ, sometimes to an extent to cause deafness, though at others only to an immaterial degree. It is improbable, from its mode of formation, that the Eustachian tube is imperfectly developed, independently of malformation of the tympanum, or of the fauces; its malarrangement is co-existing with more extensive imperfection. An occasional cause of cognate cophosis exists in the inspissation of mucus, or muciform matter, in the tympanic cavity, or in the Eustachian tube, or occupying both canal and cavity. The exact condition of the middle Ear should therefore always be ascertained, as if this cause of the defect alone exists, it may be removed; both the diagnosis and removal being effected through the medium of catheterism of the Eustachian tube.

Malformations in the external auditory canal are not common, though occasionally they occur; the most frequent is unnatural diminution in capacity, which, if not extreme, will produce but little inconvenience, but it may

exist even to obliteration of the tube. When such deficient calibre is confined to the cartilaginous and the fibrous textures, it may often be remedied by the use of tubes and tents; but when the malformation is seated in the bony structure, the hope of relief must be very faint. In the same manner, ossification of the membrana tympani hardly admits of remedy. As the mucous membrane of the Eustachian tube and tympanum, so its counterpart, the dermoid canal of the outer Ear, may be occupied by inspissated sebaceous, or ceraceous matter, the ordinary deposit upon the surface of the newly-born infant, which is easily removed soon after birth.

Maldevelopment of the auricle alone cannot occasion interference with hearing, and therefore need hardly be alluded to in this general summary.

Dissections of the Ear the most particular often fail in evidencing the abnormal cause of congenital deafness, which is most probably then concealed in the nervous apparatus of the organ, either of the labyrinth or of the tympanum: vitiations in these structures, too minute for observation, may entirely annul the function.

It appears that every part of the nervous system, and in a marked manner each nerve of special sense, requires the application of its own peculiar exciting agent, gradually and frequently repeated, to stimulate it, as it were, to perform its appropriate function; hence the truly animal senses are not in operation till some time after the birth of the infant. This circumstance probably depends upon the sense itself, or that part of the brain with which it is connected, being perfected only AFTER birth. The period required for this capability of action varies in individuals, from a few days to several months, and sometimes never arrives: hence one cause, and the Author imagines, the most frequent and irremediable, of deaf-dumbness.

The vast improvements in the tuition of the sourd-muet having introduced speech into his acquirements, the slightest amount of hearing becomes an object of great importance; hence, whatever may be the cause of the defect, exercise of the organ should be diligently persevered in, to augment, or at least to retain, what little function may exist.

The ACQUIRED causes of deafness occur in each division of the Ear, and not infrequently in two, or in all three at the same time. Though the attention of the Surgeon is generally directed, and oftentimes exclusively, to the External Ear, it has been shown that the disease causing the imperfection is more frequently seated in the tympanum or the labyrinth.

The tympanum is by far the most common seat of disease; either in the form of catarrh, acute or chronic, producing temporary or more permanent accumulations of mucus; or of more serious inflammation terminating in suppuration, implicating and ulcerating the membrane, sometimes with the loss of the ossicles, and the formation of fungi protruding through the aperture into the meatus. It is fortunate that in all these apparently untoward cases, much relief may be afforded; and in the very common affection, strumous thickening of the mucous membrane, producing accumulation, a cure may be fairly expected. The Eustachian tube participates in the diseases of the tympanic cavity, except probably in the fungi or vegetations proceeding from its mucous membrane, which are rare in the tube, though so common in the cavity. Stricture of the Eustachian tube, so frequently alluded to as a cause of deafness, is an uncommon occurrence. Affections of the labyrinth are the next in frequence, as the acquired causes of cophosis; of these, the erethitic or excited state of the auditory nerve, generally occurs in young and middle-aged persons; and unfortunately is more frequently than otherwise uninfluenced by surgical appliances, a minority of cases only yielding to remedies. The torpid condition of the acoustic nerve, although not confined to old age, is almost peculiar to that period of life, and is even more beyond the reach of art than the erethitic affection.

The diseases of the labyrinth coincident with, or consequent upon affections of the brain, not unfrequently continue after the original malady has subsided. The Author has witnessed several such cases, in which the loss of function was more complete than from any other cause, not excepting even malformation. From the experience of one instance in a child, — in whom cophosis, consequent upon disease of the brain excited by den-

tition, was so perfect, that of necessity dumbness existed during five or six years — yielding to the influence of mercury, whereby hearing, and consequently speech were restored; and of others in which some decided improvement occurred, the Writer indulges the hope, that even these deplorable cases may occasionally admit of relief.

The outer Ear is less frequently diseased sufficiently to cause serious deafness than is usually imagined, and hence the frequent inutility, and often injuriousness, of acoustic applications and nostrums, which are almost uniformly applied to the outer canal. The unhealthy condition of this auditory tube, so frequently accompanying a similar state of the tympanum, the real cause of the cophosis, is very likely to mislead the casual observer; and it is not uncommon to hear the dryness of the meatus — symptomatic of diminished energy of the auditory nerve — asserted as the origin of the lessened function. Though it is probable that every unhealthy state of this structure will interfere with hearing, yet it is almost certain that nothing short of mechanical interruption to the transmission of sound, can produce any material effect; hence may be enumerated the tumefaction of the lining membrane; polypus, fungus, or vegetations of the canal; inspissated wax, and foreign bodies of all kinds. It is evident that the effect of extraneous materials and of insects, will be in proportion to their quantity, and their proximity or attachment to the membrane of the tympanum. The fungi so constantly seen at the bottom of the auditory canal are, with but few exceptions, products of the diseased mucous membrane of the tympanum projecting through an aperture in the membrane, and in a large majority of cases the effect of scarlet fever. It is gratifying to the Surgeon, that all these cases are improvable by his art, and frequently curable.

The allusion in this Summary to the extent of surgical aid in acquired causes of deafness, though brief, is sufficient to point to the fact, that in the present state of knowledge, it is to a distressing degree unavailable, and that to a certain extent it will ever remain so; yet the daily advance of science justifies the hope, that more may be achieved in this department also for suffering humanity.

Mechanical contrivances have been devised, from time immemorial, to obviate the effects of deafness by augmenting the quantity of sonorous waves transmitted to the Ear. The empiricism so often accompanying the laudations of acoustic apparatuses, attributing to them far other than mere mechanical effects, is much to be deplored. As all other remedies whose effects are striking and beneficial, so Ear cornets and trumpets are exceedingly likely to be abused, by being adopted too early and used too constantly. The patient should be impressed with the fact, that the instrument is useful only by increasing the undulations conveyed to the organ, and he hears consequently better, in the same manner as he would a voice loud to the same degree; and that in proportion as the sound is augmented, and constantly applied, the nerve, for the faulty condition of which the instrument is generally required, will become accustomed to the greater excitement, its torpidity or erethism will increase, and the deafness become worse: the instrument should therefore be had constant recourse to only when every sound is lost without it; and when hearing exists even to a very limited degree, this valuable, yet often dangerous aid, should be used only when the sound is very low or at a distance, or it is important to catch it distinctly.

The most useful are the common cornets, and they should be large and long, shaped upon the principles described in the chapter on the Physiology of Hearing, when alluding to the speaking trumpet, though reversed, in order to condense most effectually the waves of sound. Certain materials seem to add to the effect by their greater vibratibility, and hence the bell, or better still, the gong, metal is extolled. A simple reflector behind the Ear, even so imperfect a medium as the hand, has very considerable effect. These instruments are manufactured of very various shapes and sizes, sometimes without much reason, but generally for the important one of convenience to the wearer, with the least possible desight. For these purposes they are often furnished with springs for securing them, which is a source of great accommodation to those who wear them habitually.

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